United States Department of Agriculture

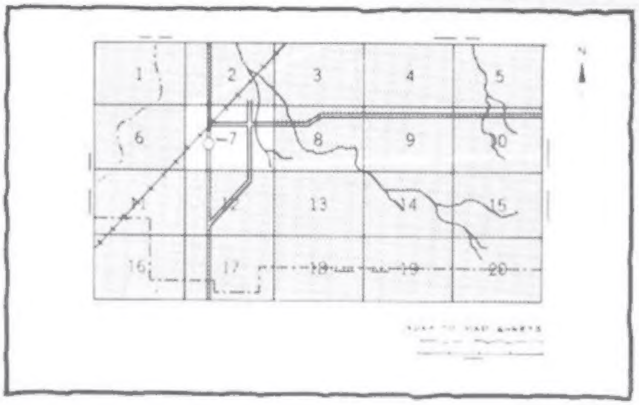
Soil Conservation Service

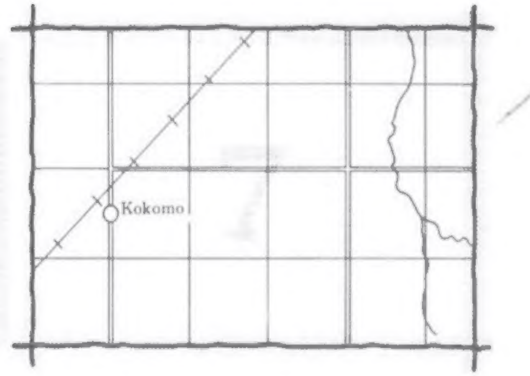
In cooperation with Minnesota Agricultural Experiment Station

Soil Survey of Stearns County Minnesota

HOW TO USE

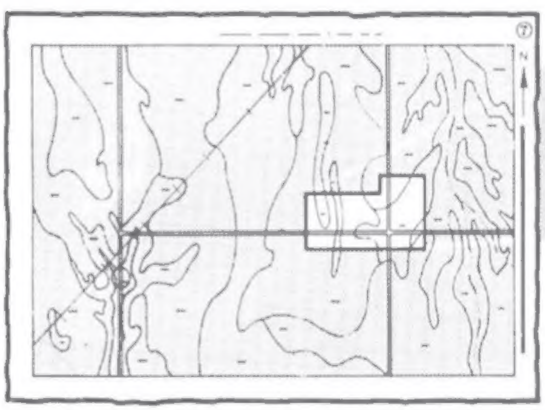
1. Locate your area of interest on the "Index to Map Sheets."

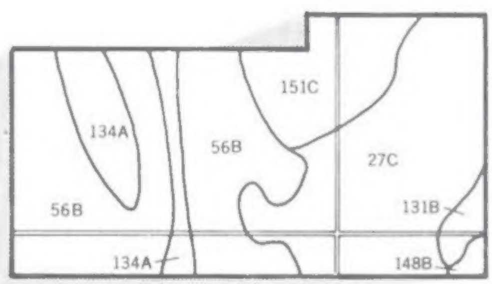




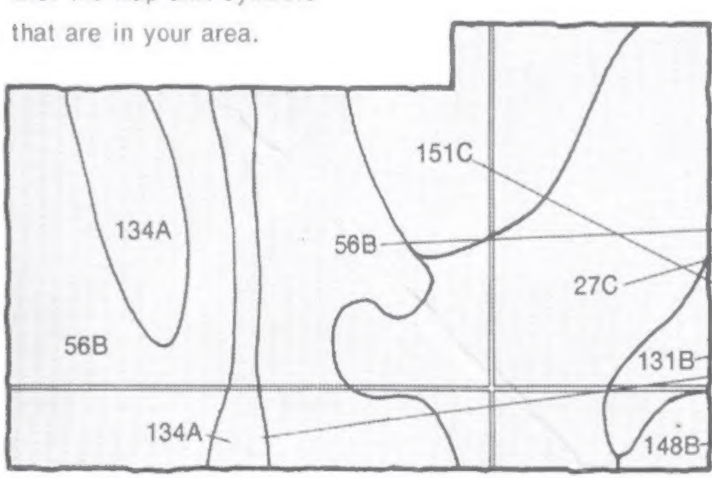
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area.

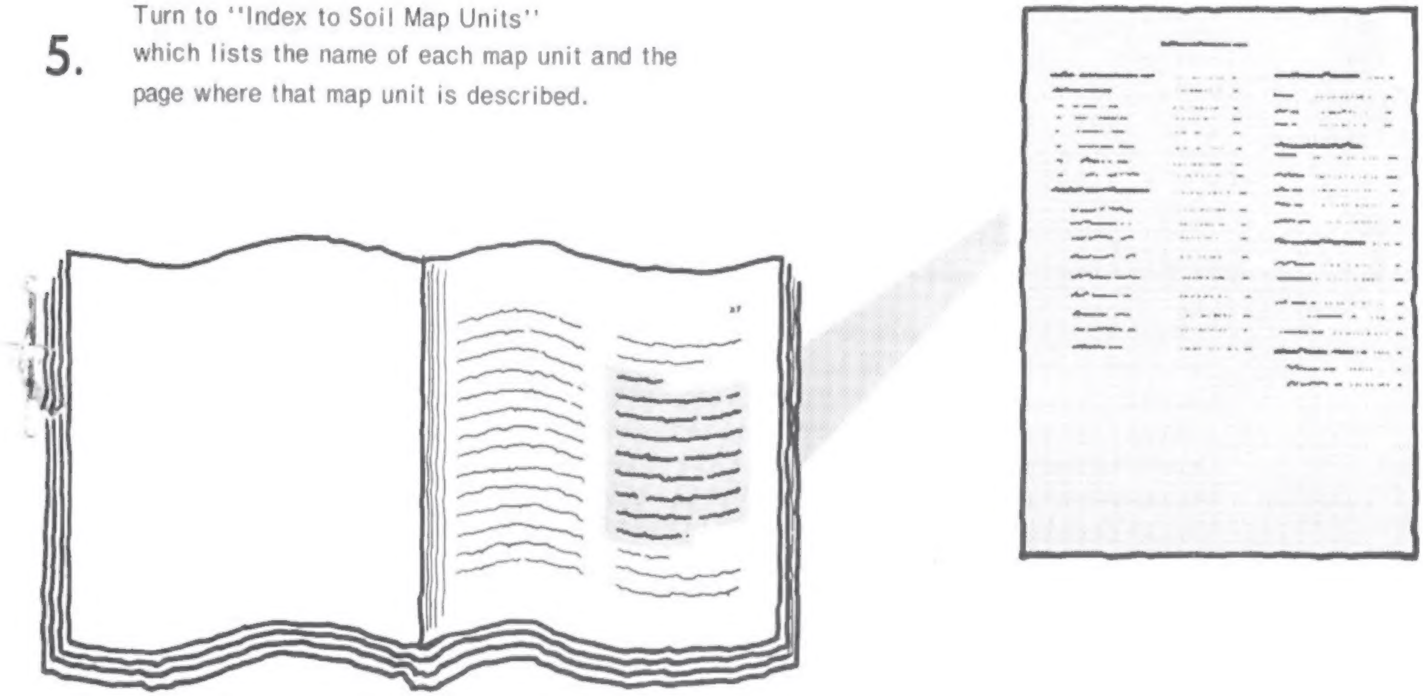


Symbols

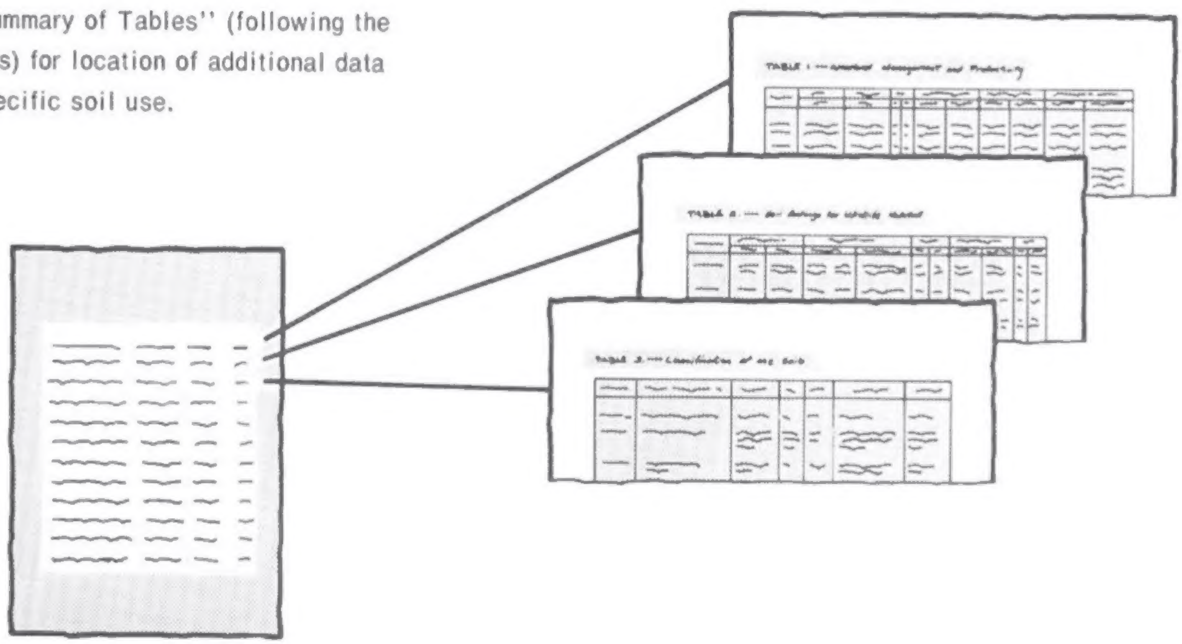
27C
56B
131B
134A
148B
151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture, Soil Conservation Service, and the Minnesota Agricultural Experiment Station in cooperation with the Agricultural Extension Service, the Soil and Water Conservation Board, and the Stearns County Soil and Water Conservation District. The survey was funded in part by the Legislative Commission for Minnesota Resources and by Stearns County. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1980. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Stearns County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Terraced cropland in an area of the Holdingford-Growton association. Most of the contour strips are in alfalfa-bromegrass; the others are ready to be seeded to small grains and corn. Grassed waterways crosswise to the contour strips help control water erosion. Two Rivers Lake is visible in the distance at left.

Contents

Soil Series

Issued May 1985

Index to Map Units

Summary of Tables

Foreword

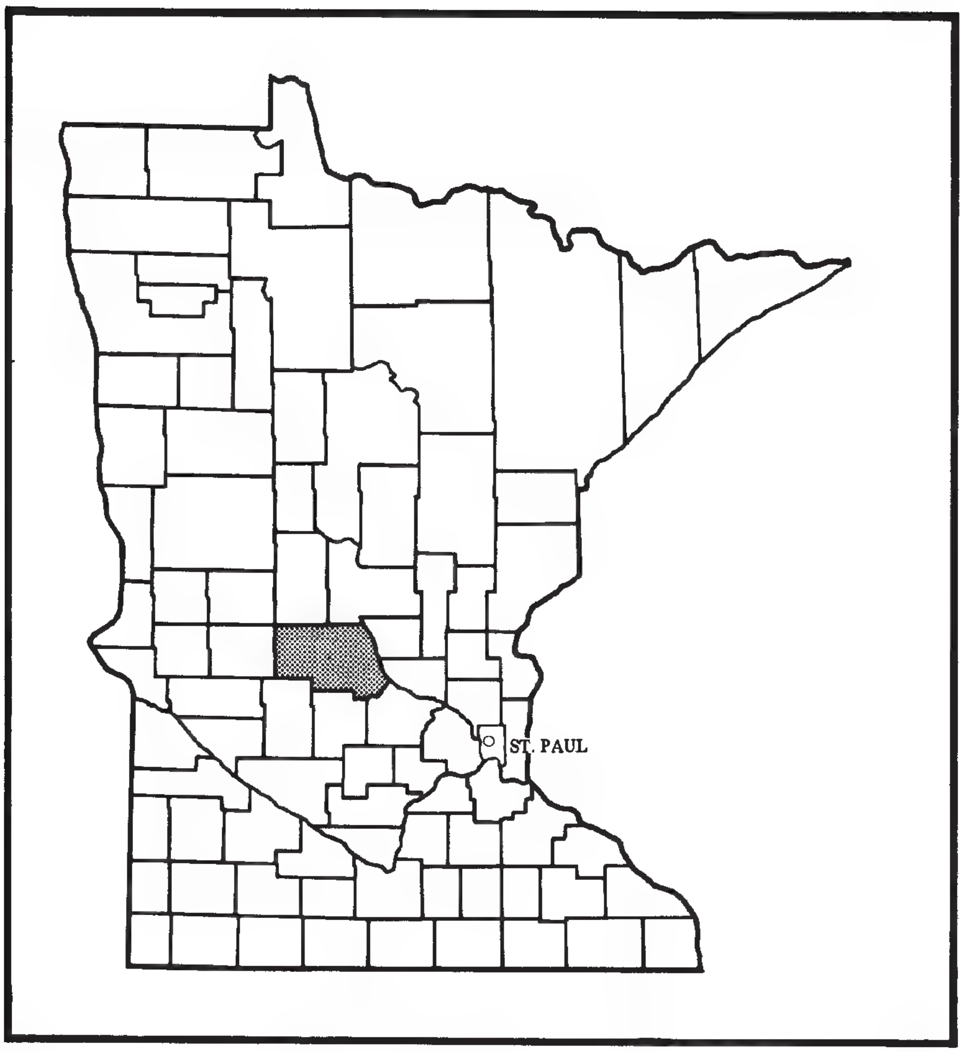
This soil survey contains information that can be used in land-planning programs in Stearns County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Donald G. Ferren
State Conservationist
Soil Conservation Service



Location of Stearns County in Minnesota.

Soil Survey of
Stearns County, Minnesota

By Charles K. Sutton, Soil Conservation Service

Fieldwork by Allan G. Giencke, Rodney B. Heschke, Michael L. Lieser,
Charles T. Saari, and Charles K. Sutton, Soil Conservation Service;
Roger L. Berggren, Jerome F. Gorton, Ronald R. Schwartz, and Bradley C. Wenz,
Minnesota Agricultural Experiment Station;
and Nancy Schumacher, Stearns County Soil and Water Conservation District

United States Department of Agriculture, Soil Conservation Service
In cooperation with Minnesota Agricultural Experiment Station

STEARNS COUNTY is in the central part of Minnesota. It has a land area of 858,880 acres and a water area of approximately 33,280 acres. Stearns County is bordered on the east by the Mississippi River, which divides the county from Benton and Sherburne Counties; on the south by Wright, Meeker, and Kandiyohi Counties; on the west by Pope and Douglas Counties; and on the north by Todd and Morrison Counties. St. Cloud is the county seat.

The soils in Stearns County range from dark to light in color and from level to very steep. They formed in glacial material. The original vegetation was medium and tall prairie grasses and mixed hardwood forest. Some of the soils in the county have been altered by urbanization and other activities of man.

General Nature of the County

Farming is the leading enterprise in Stearns County. Dairying is the principal kind of farming. Poultry, livestock, and cash-grain crops are also important sources of farm income. Corn, oats, and hay are the main crops grown. In turn, agricultural production generates industry and commerce: packing firms process beef, turkeys, and chickens, and dairies process raw milk into milk for drinking, cream, butter, ice cream, cheeses, and dried or dehydrated milk.

Manufacturing is also economically important in the county. Rock quarries provide granite for memorials, monuments, and building stone. Other light industries produce various printing products; railroad cars; home freezers and refrigerators; dairy equipment; turbines for the production of electricity; and many other items. The county also has publishing and communications, merchandising, recreational, and educational industries.

The large tracts of woodland in the eastern part of Stearns County provide some cash income from the sale of firewood, veneer, and sawlogs. The wooded tracts also afford attractive homesites for the expanding population around the metropolitan area. The forested land and the many lakes are becoming increasingly important as recreational areas.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Stearns County is cold in winter and is quite hot with occasional cool spells in summer. Precipitation during the winter frequently occurs as snowstorms; during the warm months it is chiefly showers, which are heavy, when warm, moist air moves in from the south. Total annual rainfall normally is adequate for corn, soybeans, and small grains.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Collegeville, Minnesota in the period 1951 to 1975. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is about 14 degrees F, and the average daily minimum temperature is 5 degrees. The lowest temperature on record, which occurred at Collegeville on January 15, 1972, is -34 degrees. In summer the average temperature is 68 degrees, and the average daily maximum temperature is 79 degrees. The highest recorded temperature, which occurred on July 17, 1964, is 99 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 21 inches, or 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18 inches. The heaviest 1-day rainfall during the period of record was 5.84 inches at Collegeville on May 22, 1962. Thunderstorms occur on about 36 days each year, and most occur in summer.

The average seasonal snowfall is about 48 inches. The greatest snow depth at any one time during the period of record was 41 inches. On the average, 61 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The sun shines 65 percent of the time possible in summer and 40 percent in winter.

Tornadoes and severe thunderstorms strike occasionally. These storms are local and of short duration. They cause sparse damage in narrow belts. Hailstorms occur at times during the warmer part of the year in irregular patterns and in relatively small areas.

History

Shortly after the last glacial ice receded, a race of small-statured people, resembling the modern Eskimos, became the first known inhabitants of the area. They were later supplanted by a larger, more aggressive race thought to be Indians of Siouxan stock. Algonquians later occupied the forested areas, while the Siouxans, later known as Dakotas, moved out onto the prairie. In 1825, the two tribes finally agreed on a boundary to separate their territories, which ran from east to west across what is now Stearns County.

The first white men thought to have visited the area were two Frenchmen, Groseilliers and Radisson, who were searching for buffalo in 1660. Others who came later were LeSueur and Charleville in 1690, Zebulon Pike in 1805, Lewis Cass and Henry Schoolcraft in 1810, and J.N. Nicollet, who made a map of the area in 1838.

Settlement was slow until the United States negotiated treaties with the Indians in 1847 and 1851. Trappers, traders, hunters, and soldiers were followed by settlers, lumberjacks, artisans, storekeepers, speculators, professional people, and politicians. The first permanent settlement in the county occurred in 1851 when John Wilson, a sawmill operator, purchased the land that is presently the business section of the city of St. Cloud.

Stearns County was established on February 20, 1855, and was named after Charles Thomas Stearns, a member of the Territorial Legislature. The county has 37 townships and 29 incorporated villages and cities. Its population in January 1979 was estimated at 102,000.

Farming and lumbering were the main attractions to the early settlers. Lumbering in the county was generally confined to cutting and processing northern hardwoods. Some northern pine was processed along the Mississippi River when log rafts were floated downstream from northern sites. The first farmers settled along or near the rivers and streams because it was easier to clear the land for cropping and because water power was at hand to run sawmills and gristmills. Wheat was the main crop in this early period. Corn, oats, and soybeans are the major money crops today.

Transportation and Markets

Stearns County is traversed by six railway lines. One line in the southern part of the county provides service to the villages of Kimball, Eden Valley, Paynesville, Belgrade, and Brooten. A second line crosses the county diagonally from southwest to northeast and serves the villages of Brooten, Elrosa, Greenwald, New Munich, Albany, and Holdingford. A third line serves the south-central part of the county; from the city of St. Cloud it runs southwest through villages of Rockville, Cold Spring, Richmond, Roscoe, and Paynesville. A fourth track, from east to northwest, serves St. Cloud, St. Joseph, Collegeville, Avon, Albany, Freeport, Melrose, and Sauk Centre. A fifth line runs southeast to northwest and connects the village of Clearwater with St. Cloud. A sixth line, in the northwest corner of the county, serves the village of Sauk Centre.

The major highways are paved or blacktopped. Interstate Highway 94 crosses the county diagonally from southeast to northwest. U.S. Highway 71 crosses the county from north to south on the western side. Minnesota Highway 23 crosses the county from east to southwest, and Minnesota Highway 55 crosses from southeast to west. Minnesota Highways 4, 15, 22, 24, and 28 serve parts of the county. Graveled or blacktopped county and township roads serve the farms.

Livestock generally are taken by truck to St. Cloud or South St. Paul. Poultry are processed at Cold Spring, Melrose, St. Cloud, or Willmar. Grain elevators are

located in most communities throughout the county. Most of the milk is marketed as whole milk and picked up by truck. A large cheese processing plant is located in Melrose. Creameries operate in Albany, Paynesville, Sauk Centre, St. Cloud, and Watkins.

Water Supply

The water supply is drawn from two major sources. These sources are the sand and gravel deposits in glacial drift and the rivers and lakes, which contain an abundant supply of relatively pure water. Municipalities that utilize lake and river water process it in filtration plants before it is put to domestic use.

The glacial drift is thick on the ground and terminal moraines, but in places granitic bedrock protrudes through the glacial sediment. The drift is mainly 100 to 200 feet thick; it ranges in thickness from 0 to approximately 350 feet. Most of the water is obtained from sand and gravel deposits in the drift. The opportunities for development of a good water supply are better on the thicker parts of the drift, which have more aquifers.

Most of the water is very hard and contains a high concentration of dissolved solids, mainly calcium, magnesium, and iron. The water in the lakes and rivers is somewhat softer.

On the outwash plain bordering the Mississippi River, the drift generally is too thin to be a reliable source of water for such a large community as St. Cloud, so this city draws its supply from the river.

In the eastern part of the county, the glacial drift rests directly on Precambrian rocks. These rocks are some of the oldest on earth. They consist mostly of quartz diorite, granodiorite, and quartz monzonite. Water yields generally are limited because of the small size and poor connection of fractures and joints in the bedrock, but water-yielding weathered zones are common.

Many excavated pits and some ponds provide water for livestock and for fire protection; the water is not suitable for domestic use. The pits have been dug on bottom land and in other areas of poorly drained soils. They collect runoff and are partly filled by ground water. Farm ponds are built on intermittent streams and in drainageways. Some ponds are spring-fed.

Farming

The number of farms in Stearns County fell slightly from 3,955 in 1975 to 3,890 in 1977. During the same period, the average size of farms in the county increased from 195 to 198 acres. There was about 769,800 acres used for farming in 1977.

Corn is the most important crop. The acreage in hay, the second most important crop, has remained at about 150,000 acres. The trend has been toward more corn grown for grain along with other cash crops, for example, wheat and soybeans. In 1966, about 138,000 acres was in corn, 121,900 acres in small grains, and 143,300 acres in hay. In 1977, about 277,000 acres was in corn, 134,000 acres in small grains, and 152,000 acres in hay.

Stearns County leads the state in number of cattle and calves, in milk production, and in total farm cash income. It ranks eighth in the nation in milk production. It has the largest pig crop in the state and ranks second in number of hens and pullets and in the production of oats. The number of milk cows has decreased slightly, but total milk production has increased somewhat through culling, better breeding, and improved nutrition. In turkey production, Stearns County ranks third among the counties in Minnesota, which is the largest producer in the nation.

Physiography, Relief, and Drainage

Stearns County is mostly an undulating plain. Slopes are irregular and short, generally less than 200 feet long. The surface drainage pattern is young. Shallow, closed depressions are common. The eastern part is more rolling and has steeper slopes than the rest of the county. The outwash plains are nearly level. Large areas of the glacial till plain in the western part of the county are also nearly level.

Across the county from west to east, the descent in elevation is about 250 feet in 48 miles, and the descent from north to south is about 135 feet in 30 miles. The elevation is 1,350 feet above sea level in the northwest corner of the county, 1,280 feet in the southwest corner, 1,030 feet in the northeast corner, and 947 feet in the southeast corner, which is the lowest point in the county. The highest point, which is 1,460 feet above sea level, is in the east-central part of the county in section 20 of Collegeville township.

All runoff in the county flows into the Mississippi River. Tributaries of the Sauk River drain the northwestern and central parts, or about 46 percent of the county. The North Branch and the Middle Branch of the Crow River drain the southwestern part, or about 19 percent. The Mississippi River and its tributaries drain the northeastern, eastern, and southeastern parts, or about 35 percent (*4, 5*).

The eastern and western parts of the county are underlain by igneous and metamorphic rocks, which are dominantly quartz diorite, granodiorite, and quartz monzonite (*11*). The central part is underlain by sedimentary rocks commonly known as argillite and graywacke. The igneous or granitic bedrock outcrops through the glacial drift mantle in the St. Cloud, Rockville, and Cold Spring areas. The mantle of glacial material ranges in thickness from about 50 feet in the eastern part to 350 feet in the township of Collegeville and is about 200 to 250 feet thick in the western part of the county (fig. 1). Sedimentary material of Cretaceous age, which overlies the granitic bedrock, is present only in scattered areas in the southern part of the county. It

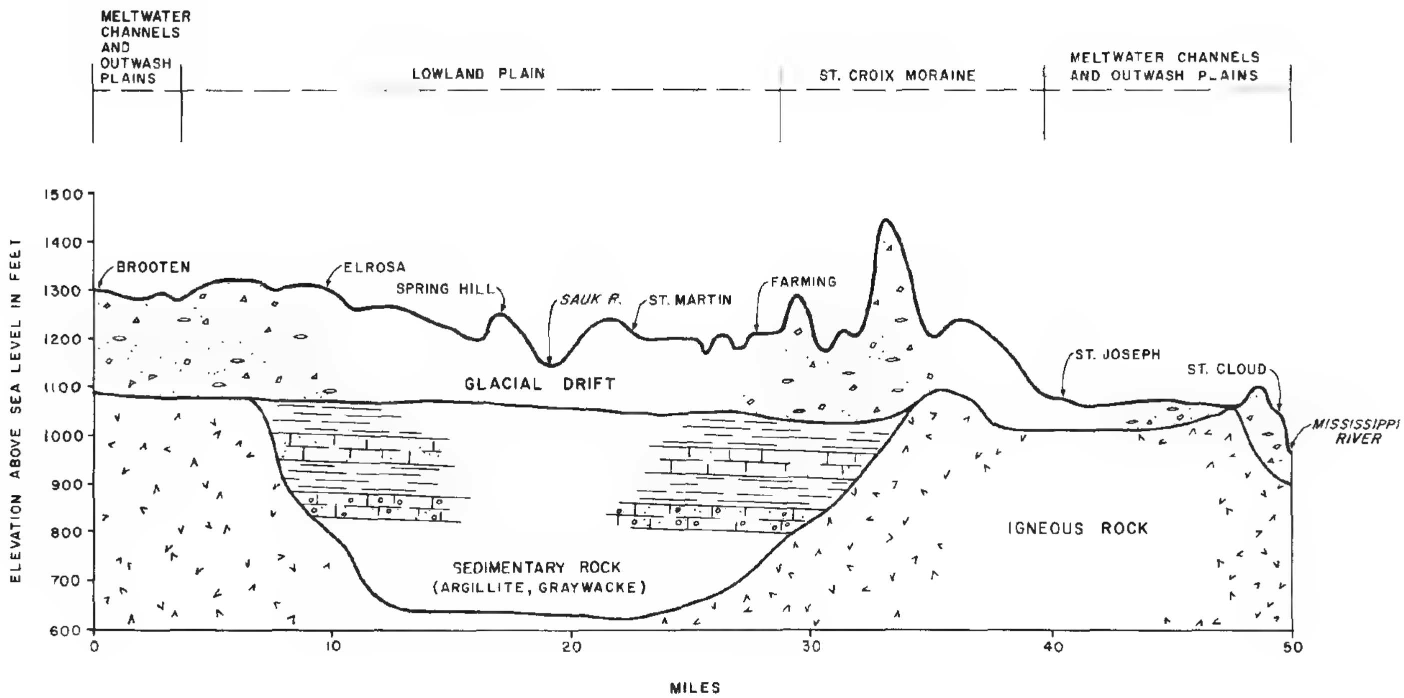


Figure 1.—Cross-sectional (west to east) diagram of Stearns County, showing differences in elevation, thickness of glacial drift, and kinds of underlying bedrock.

was deposited in former inland seas and consists mainly of shale, sandstone, siltstone, and clay.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of

horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas, called soil associations, that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

Nearly level to sloping soils that formed in a sandy or loamy mantle and the underlying noncalcareous, sandy outwash under savanna vegetation

These are sandy or loamy soils on outwash plains and stream terraces. The soils are excessively drained and well drained. They formed under savanna vegetation consisting of prairie grasses and scattered mottes of open oak forest.

1. Hubbard-Dickman Association

Nearly level to sloping, excessively drained and well drained, coarse textured and moderately coarse textured soils on outwash plains and stream terraces

The soils making up this association are mainly on broad, nearly level and undulating outwash plains and stream terraces. The slopes are 0 to 12 percent.

This association makes up about 9 percent of the land area of Stearns County. It is about 35 percent Hubbard soils, 20 percent Dickman soils and similar soils, and 45 percent soils of minor extent (fig. 2).

The Hubbard soils are excessively drained and are nearly level to sloping. They are on broad flats, knolls, and convex or concave side slopes. Typically, the surface layer is black loamy sand. The subsurface layer is very dark grayish brown loamy sand. The subsoil is dark brown, brown, and yellowish brown sand. The underlying material is yellowish brown and light yellowish brown sand. The seasonal high water table is at a depth of more than 6 feet.

The Dickman soils are well drained and are nearly level to gently sloping. They are on flats and low, convex slopes and knolls. They have a surface layer of black sandy loam and a subsurface layer of very dark grayish brown sandy loam. The subsoil is dark yellowish brown sandy loam in the upper part and dark yellowish brown sand in the lower part. The underlying material is dark yellowish brown coarse sand. The seasonal high water table is at a depth of more than 6 feet.

The minor soils in this association are Duelm, Hawick, Isan, Markey, and Nymore soils. The Duelm soils are somewhat poorly drained and are on low flats. The Hawick soils are excessively drained and are on convex knolls and ridges. The Isan soils are poorly drained and are in depressions. The Markey soils are very poorly drained and are in deep depressions. The Nymore soils are excessively drained and are in the more sloping areas.

The soils are used mainly for dairy farming. Corn, small grains, and hay are the major crops. Management concerns are overcoming droughtiness caused by the low available water capacity and controlling soil blowing. Improving the low natural fertility and, on the more poorly drained soils, maintaining tilth are also concerns. The soils have fair suitability for pasture and woodland. They are well suited to building site development. The underground water supply and nearby lakes and streams can become polluted if septic tank absorption fields or other sanitary facilities are placed on these soils.

Nearly level to very steep soils that formed in a loamy or sandy mantle and the underlying sandy outwash under prairie vegetation

These are loamy and sandy soils on outwash plains and stream terraces. The soils are excessively drained, somewhat excessively drained, well drained, moderately well drained, and poorly drained. They formed mainly under prairie vegetation, but forest vegetation encroached on some of the soils.

2. Estherville-Hawick Association

Nearly level to very steep, somewhat excessively drained and excessively drained, moderately coarse textured and

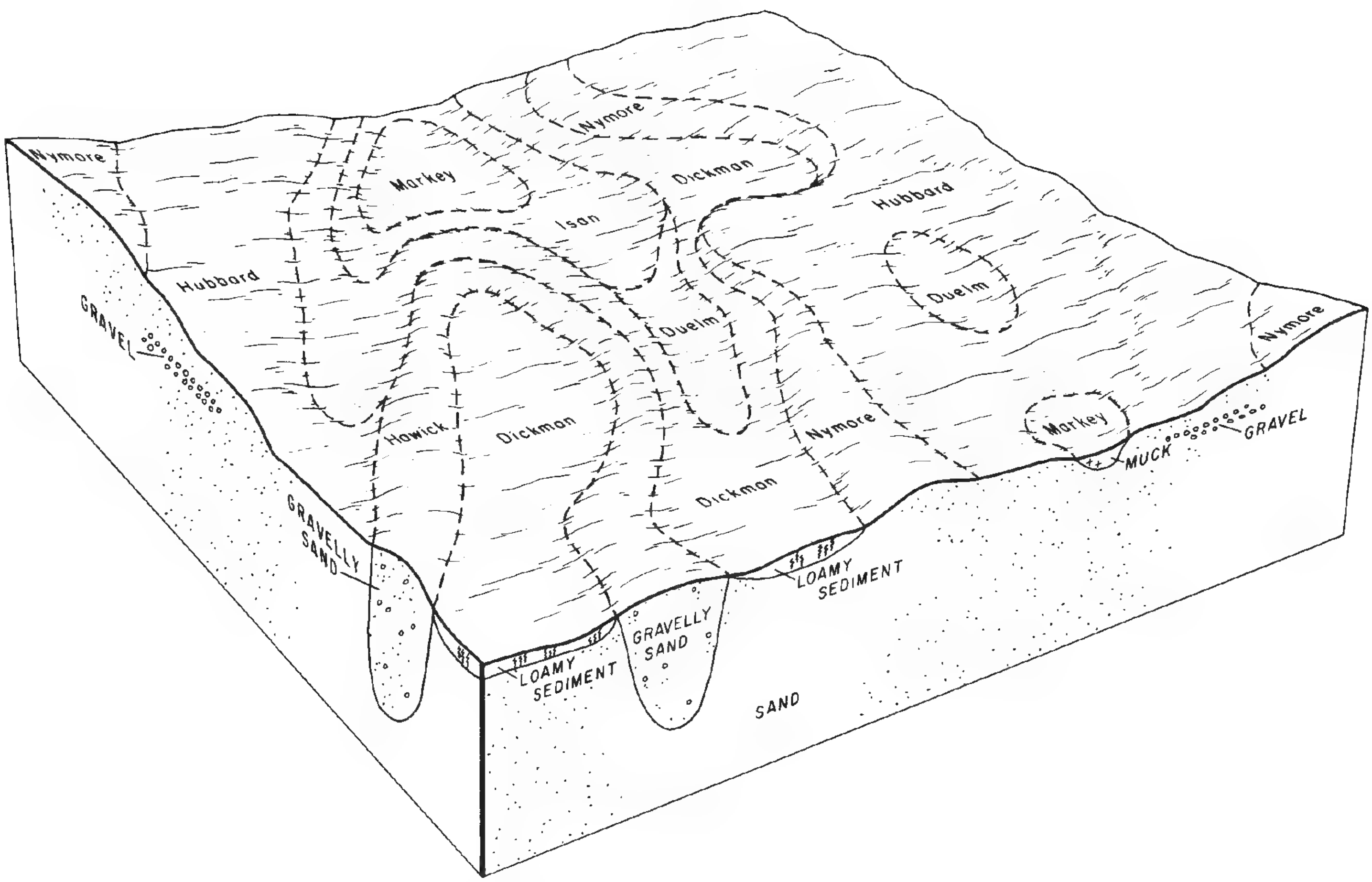


Figure 2.—Pattern of soils and underlying material in the Hubbard-Dickman association.

coarse textured soils on outwash plains and stream terraces

The soils making up this association are on broad, mainly nearly level and undulating outwash plains and stream terraces. In some areas they are also on rolling to very steep side slopes. The slopes are 0 to 40 percent.

This association makes up about 12 percent of the land area of the county. It is about 40 percent Estherville soils, 25 percent Hawick soils, and 35 percent soils of minor extent (fig. 3).

The Estherville soils are somewhat excessively drained and are on nearly level to steep slopes. They are on broad flats, knolls, and rolling convex and concave side slopes. Typically, the surface layer is black sandy loam. The subsurface layer is very dark grayish brown sandy loam. The subsoil is dark brown and dark yellowish brown sandy loam. The subsoil is dark brown and dark yellowish brown sandy loam and loamy coarse sand. The underlying material is yellowish brown, brown, and pale brown gravelly coarse sand. The seasonal high water table is at a depth of more than 6 feet.

The Hawick soils are excessively drained and are on undulating to very steep slopes. They are on crests and side slopes of rises, knolls, hills, and ridges. They have a surface layer of very dark brown loamy sand and a subsoil of dark yellowish brown loamy coarse sand and coarse sand. The underlying material is dark yellowish brown gravelly coarse sand and pale brown coarse sand. The seasonal high water table is at a depth of more than 6 feet.

The minor soils in this association are Biscay, Markey, Osakis, and Regal soils. Biscay and Regal soils are poorly drained and are on wet flats. Markey soils are very poorly drained and are in depressions. Osakis soils are moderately well drained and are on broad flats and low, convex rises.

The soils in this association are used mainly for dairy farming and for raising turkeys. Corn, small grains, and alfalfa are the main crops. Some small areas are used

for specialty crops, such as potatoes, snap beans, sunflowers, seed corn, and sweet corn.

If these soils are farmed, the main concerns in management are the low available water capacity, low natural fertility, and a hazard of wind erosion. In the low areas, wetness is a concern. Estherville and Hawick soils are suited to use as pasture and to windbreaks. They are suited to building site development, but there is a hazard of pollution to underground water supplies and nearby lakes and streams if septic tank absorption fields or other sanitary facilities are placed in areas of this association.

3. Regal-Osakis Association

Nearly level, poorly drained and moderately well drained, medium textured soils on outwash plains and stream terraces

The soils making up this association are on nearly level outwash plains and stream terraces dissected by many drainageways. The slopes are 0 to 2 percent.

This association makes up about 4 percent of the land area of the county. It is about 40 percent Regal soils, 30 percent Osakis soils, and 30 percent soils of minor extent.

The Regal soils are poorly drained and are nearly level. They are on slightly concave, broad flats and some slightly convex rises within areas of wetter minor soils. Typically, the surface layer is black loam. The subsurface layer is black and very dark grayish brown loam. The subsoil is dark grayish brown, mottled sandy loam. The underlying material is grayish brown and light brownish gray, mottled loamy coarse sand and gravelly coarse sand. The seasonal high water table is at a depth of 1 foot to 3 feet.

The Osakis soils are moderately well drained and are nearly level. They are on concave flats on uplands, slightly convex rises within areas of wetter minor soils, and the concave lower part of slopes. They have a surface layer of black loam. The subsurface layer is very dark grayish brown sandy loam. The subsoil is dark

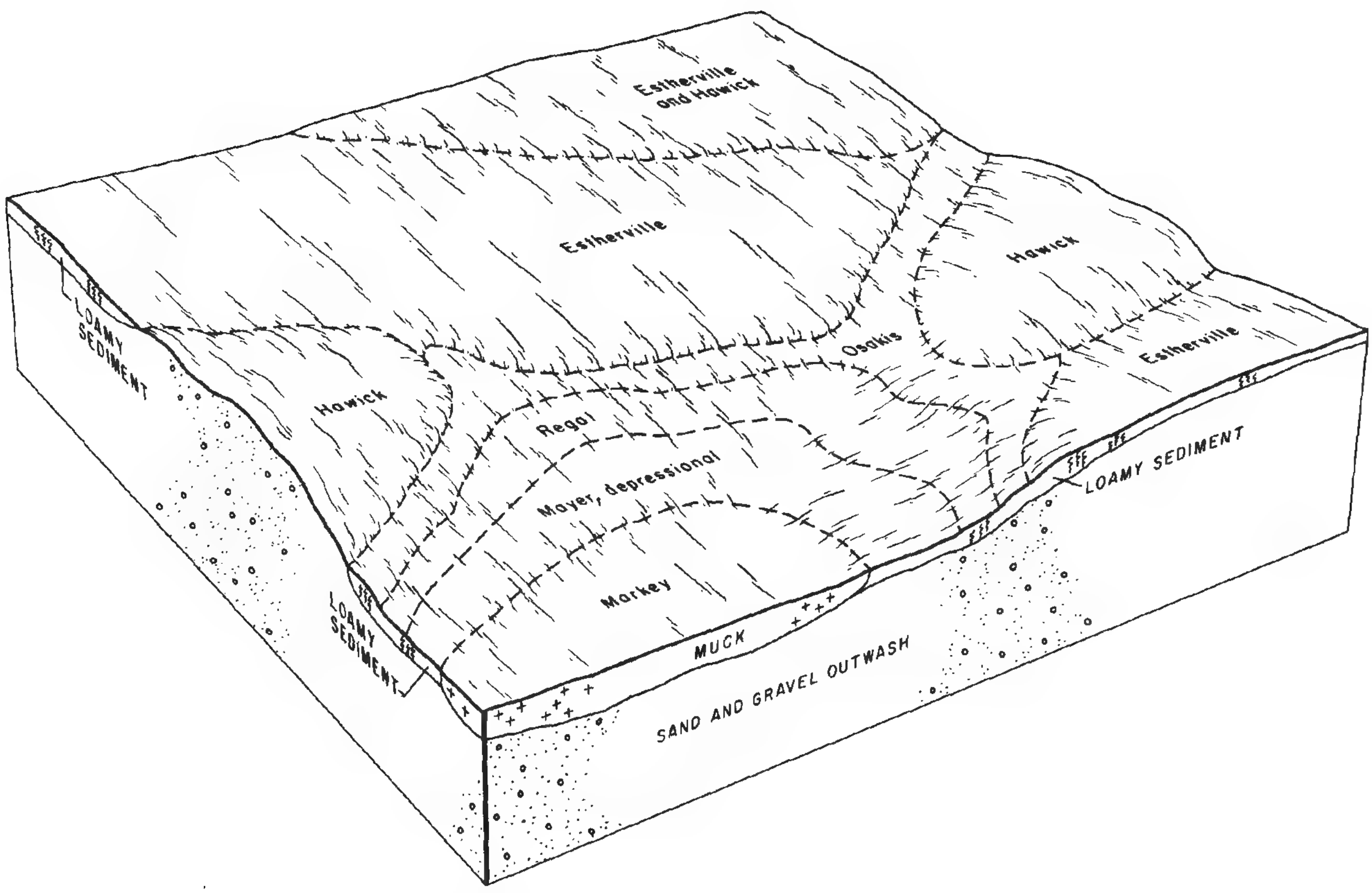


Figure 3.—Pattern of soils and underlying material in the Estherville-Hawick association.

yellowish brown, mottled sandy loam and loamy coarse sand. The underlying material is grayish brown, mottled coarse sand and gravelly coarse sand. The seasonal high water table is at a depth of 4 to 6 feet.

The minor soils in this association are the Biscay depressional, Markey, and Mayer depressional soils in the depressions, the Biscay and Mayer soils on the rim of depressions and in drainageways, and the Estherville and Hawick soils on convex rises and knolls.

The soils are mainly farmed. Corn, small grains, and hay are the main crops. Providing surface and internal drainage, maintaining or improving fertility and tilth, and controlling wind erosion are the main concerns in management. Drainage outlets are not available in some areas. The soils are well suited to use as pasture. They have fair to poor suitability for windbreaks because of the seasonal high water table. They also have fair to poor suitability for building site development because of the seasonal high water table. There is a hazard of ground water pollution if sanitary facilities are placed on these soils.

4. Dorset-Nymore Association

Undulating to steep, well drained and excessively drained, moderately coarse textured and coarse textured soils on outwash plains and stream terraces

The soils making up this association are undulating to steep. The slopes are mainly 2 to 15 percent, but they are steeper in areas of troughs and ridges, along drainageways, and around depressions. The slopes range from 2 to 25 percent.

This association makes up about 5 percent of the county. It is about 30 percent Dorset soils, 20 percent Nymore soils, and 50 percent soils of minor extent.

The Dorset soils are well drained. They are on outwash plains. They have a surface layer of black sandy loam and a dark brown sandy loam subsurface layer. The subsoil is dark brown and strong brown sandy loam, dark brown loamy sand, and dark yellowish brown coarse sand. The underlying material is brown gravelly coarse sand. The seasonal high water table is at a depth of more than 6 feet.

The Nymore soils are excessively drained. They are on undulating to steep crests and side slopes. The surface layer is very dark brown loamy sand. The subsurface layer is dark brown loamy sand. The subsoil is dark brown, strong brown, and yellowish brown sand. The underlying material is light yellowish brown and pale brown, mottled sand. The seasonal high water table is at a depth of more than 6 feet.

The minor soils in this association are Darfur, Dickman, Estherville, Hawick, and Litchfield soils. Darfur soils are poorly drained and are on wet concave flats. Dickman and Estherville soils are somewhat excessively drained and are nearly level. They are on broad flats that have plane to slightly concave slopes. Hawick soils are excessively drained and are undulating to very steep. They are on ridge crests and side slopes. Litchfield soils are moderately well drained and are on smooth, broad flats and low convex rises.

The soils in this association are used primarily for dairy farming. The steeper soils are used mainly as woodland. Corn, small grains, and alfalfa are the main crops grown.

The main concerns in management are the low available water capacity and the slope. Wind erosion and maintenance of tilth and fertility are also concerns. The soils in the more nearly level areas are suited to crops and to use as pasture and woodland. They are also suited to building site development, but there is a danger that the underground water supply can become polluted if sanitary facilities are placed on these soils.

Nearly level to steep soils that formed in a loamy mantle and the underlying sandy outwash under prairie vegetation

These are loamy soils on outwash plains. The soils are well drained and somewhat excessively drained. They formed under prairie vegetation.

5. Fairhaven-Estherville Association

Nearly level to steep, well drained and somewhat excessively drained, medium textured and moderately coarse textured soils on outwash plains, valley trains, and stream terraces

The soils in this association are mainly on broad, smooth outwash plains that have convex rises. In some areas they are on smooth, gently sloping knolls and side slopes and, less commonly, on smooth, steeper slopes along drainageways. The slopes range from 0 to 25 percent.

This association makes up about 3 percent of the land area of the county. It is about 35 percent Fairhaven soils, 30 percent Estherville soils, and 35 percent soils of minor extent.

The Fairhaven soils are well drained and are on broad, flat plains. They are mainly nearly level, but in some areas they are gently sloping. The surface layer is black loam, and the subsurface layer is very dark brown and dark brown loam. The subsoil is dark yellowish brown loam and loamy coarse sand. The underlying material is light yellowish brown loamy coarse sand. The seasonal high water table is at a depth of more than 6 feet.

The Estherville soils are on broad flats and convex knolls and are nearly level to steep. They are somewhat excessively drained. The surface layer is black sandy loam. The subsurface layer is very dark brown sandy

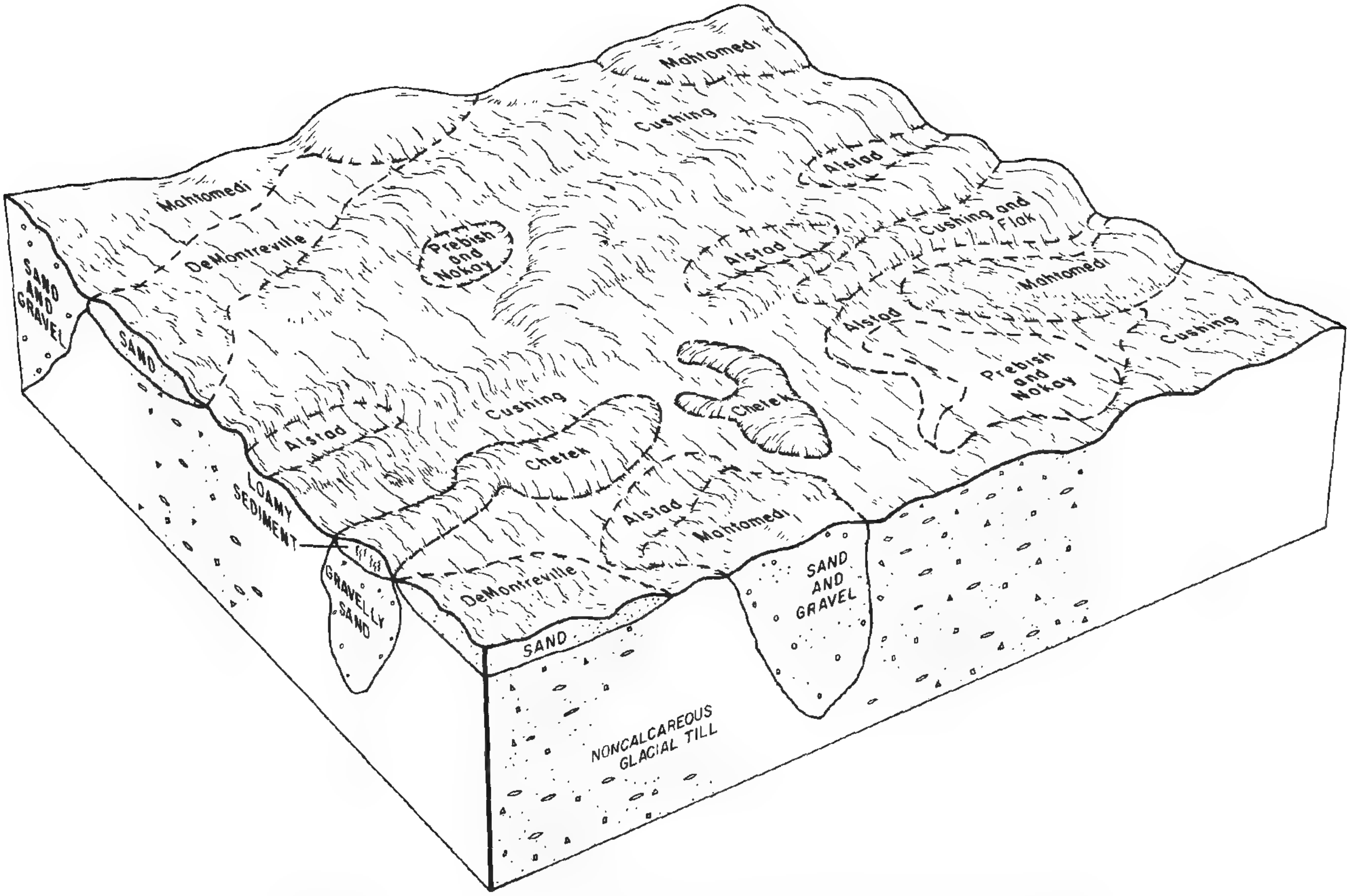


Figure 4.—Pattern of soils and underlying material in the Cushing-Mahtomedi association.

loam. The subsoil is dark brown and dark yellowish brown sandy loam and loamy coarse sand. The underlying material is yellowish brown, brown, and pale brown gravelly coarse sand. The seasonal high water table is at a depth of more than 6 feet.

The minor soils in this association are the poorly drained Biscay and Biscay depressional soils in depressions and drainageways and the well drained Dakota and Dickman soils on nearly level plains and gently sloping knolls.

The soils in this association are used mainly for dairy farming. Corn, small grains, and alfalfa are the main crops. The main concerns in management are droughtiness in periods of low rainfall, wind erosion, tilth, and low natural fertility. These soils are suited to use as pasture and to windbreaks. They are well suited to building site development, but there is a hazard of ground water pollution if sanitary facilities are placed on these soils.

Nearly level to very steep soils that formed in loamy, noncalcareous glacial till or sandy outwash under forest vegetation

These are loamy and sandy soils on ground and end moraines and outwash plains. The soils are well drained, excessively drained, and moderately well drained. They formed under deciduous forest.

6. Cushing-Mahtomedi Association

Undulating to very steep, well drained and excessively drained, moderately coarse textured and coarse textured soils on uplands

The soils making up this association are undulating to very steep and are on moraines and outwash plains. The slopes are complex and irregular and range from 2 to 40 percent.

This association makes up about 10 percent of the county. It is about 50 percent Cushing soils, 15 percent

Mahtomedi soils, and 35 percent soils of minor extent (fig. 4).

The Cushing soils are well drained. They are on summits and hillsides, on ridges around enclosed depressions, and along drainageways. They have a very dark grayish brown sandy loam surface layer and a dark brown and yellowish brown sandy loam subsurface layer. The subsoil is dark yellowish brown and dark brown sandy loam and sandy clay loam. The underlying material is dark brown sandy loam. The seasonal high water table is at a depth of more than 6 feet.

The Mahtomedi soils are excessively drained. They are on summits, side slopes, and escarpments. They have a black loamy coarse sand surface layer and a very dark grayish brown coarse sand subsurface layer. The subsoil is dark brown coarse sand, and the underlying material is brown gravelly coarse sand. The seasonal high water table is at a depth of more than 6 feet.

The minor soils in this association are Alstad, Chetek, DeMontreville, Nokay, and Prebish soils. Alstad soils are moderately well drained and are nearly level. Chetek soils are somewhat excessively drained and are nearly level to sloping. DeMontreville soils are well drained and are gently sloping to rolling. Nokay and Prebish soils are somewhat poorly drained, poorly drained, and very poorly drained. They are in depressions and on the rim of depressions.

The soils in this association are used mainly for crops and as pasture on dairy farms. Corn, small grains, and alfalfa are the main crops. Granite is quarried in a few areas. Some small areas are used for rural residences. The major limitations to nonfarm uses are the slope gradient in many areas and the moderately slow permeability of the Alstad, Cushing, DeMontreville, Nokay, and Prebish soils.

If the soils are farmed, the main concerns in management are erosion control, stone and tree removal, and maintenance of tilth and fertility. The soils are well suited to use as pasture, woodland, and building sites. Septic tank absorption fields on the soils that have moderately slow permeability have to be larger than those on the soils that have rapid and moderately rapid permeability. However, the soils that have rapid or moderately rapid permeability readily absorb effluent but do not adequately filter it.

7. Brainerd-Flak Association

Nearly level to very steep, moderately well drained and well drained, moderately coarse textured soils on uplands

The soils making up this association are on nearly level to gently sloping ground moraines and on drumlins. In some places along drainageways, the slopes are very steep. The slopes generally are smooth and uniform and mainly are 1 to 15 percent, but they range from 1 to 40 percent.

This association makes up about 4 percent of the total land area of Stearns County. It is about 35 percent Brainerd soils, 20 percent Flak soils, and 45 percent soils of minor extent.

The Brainerd soils are moderately well drained. They are nearly level to gently sloping. They are on uniform side slopes and on flats. They have a very dark brown fine sandy loam surface layer. The subsurface layer is dark grayish brown and dark brown, mottled fine sandy loam. The subsoil is dark brown and brown, mottled sandy loam and fine sandy loam. The underlying material is dark brown, mottled sandy loam. The seasonal high water table is at a depth of 1.5 to 2.5 feet.

The Flak soils are well drained. They are gently sloping to very steep. They are on crests and side slopes of drumlins. They have a black sandy loam surface layer and a brown sandy loam subsurface layer. The subsoil is dark brown sandy loam. The underlying material is also dark brown sandy loam. The seasonal high water table is at a depth of more than 6 feet.

The minor soils in this association are Cathro, Chetek, Mahtomedi, Nokay, and Prebish soils. Cathro and Prebish soils are very poorly drained; they are in depressions and drainageways. Nokay soils are somewhat poorly drained; they are on foot slopes and low-lying flats. Chetek soils are somewhat excessively drained; they are on nearly level to undulating outwash plains and ground moraines. Mahtomedi soils are excessively drained; they are on undulating to very steep slopes on glacial moraines and outwash plains.

The soils in this association are mainly cropped. Corn, small grains, and alfalfa are the major crops. The soils on steeper slopes are in pasture or woodland. Management concerns are controlling erosion on steep slopes, improving drainage on the wet soils, improving tilth, and maintaining fertility. The soils are well suited to use as pasture and woodland. They have fair suitability for urban uses. The steepness of slopes and the moderately slow permeability are the main limitations for building sites or for sanitary facilities.

Nearly level to very steep soils that formed in loamy, calcareous glacial till under forest vegetation

These are loamy soils on ground and end moraines. The soils are well drained to somewhat poorly drained. They formed under deciduous forest.

8. Nebish-Beltrami Association

Nearly level to very steep, well drained to somewhat poorly drained, moderately coarse textured and medium textured soils on uplands

The soils making up this association are on nearly level to very steep ground and end moraines. The slopes range from 1 to 40 percent.

This association makes up about 9 percent of the total land area of Stearns County. It is about 40 percent

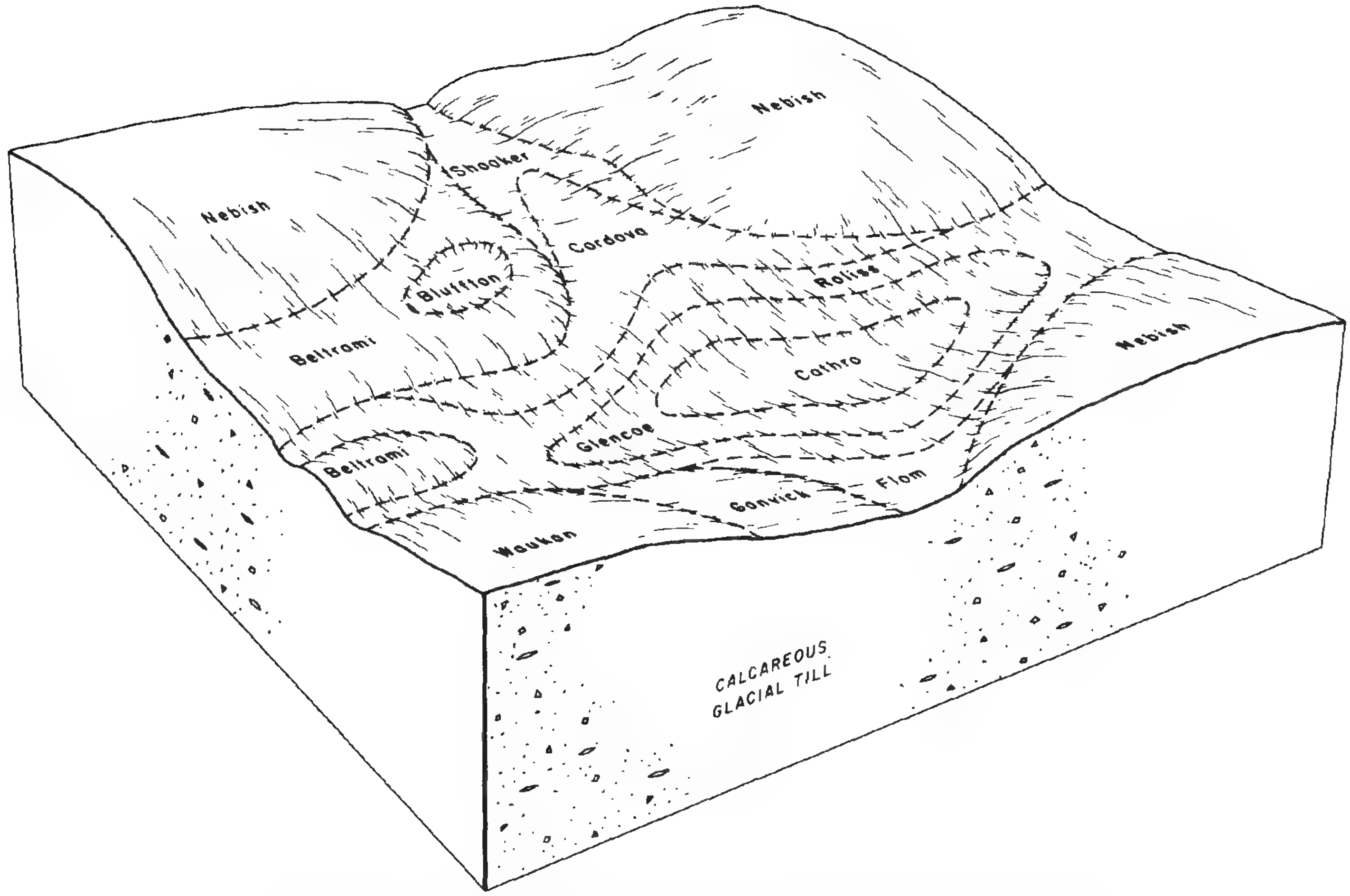


Figure 5.—Pattern of soils and underlying material in the Nebish-Beltrami association.

Nebish soils, 10 percent Beltrami soils, and 50 percent soils of minor extent (fig. 5).

The Nebish soils are well drained and are gently undulating to very steep. They are on irregular knolls and on hills, bluffs, and valley walls. They have a black sandy loam surface layer and a dark grayish brown sandy loam subsurface layer. The subsoil is dark yellowish brown and yellowish brown sandy clay loam. The underlying material is light olive brown fine sandy loam. The seasonal high water table is at a depth of more than 6 feet.

The Beltrami soils are moderately well drained and somewhat poorly drained, and they are nearly level. They are on rises, on knolls, and on the broad tops of low hills. They have a very dark gray loam surface layer and a dark grayish brown and grayish brown loam subsurface layer. The subsoil is light olive brown, mottled loam and clay loam. The underlying material is light olive brown, mottled loam. The seasonal high water table is at a depth of 2 to 4 feet.

The minor soils in this association are Bluffton, Cathro, Cordova, Flom, Glencoe, Gonvick, Shooker, and Waukon soils. Bluffton, Cathro, and Glencoe soils are very poorly drained; they are in depressions and drainageways. Cordova, Flom, and Shooker soils are poorly drained; they are gently sloping to moderately steep. Gonvick soils are moderately well drained and somewhat poorly drained; they are nearly level to undulating. Waukon soils are well drained; they are gently sloping to moderately steep.

The soils are mainly cropped. The main crops are corn, small grains, and alfalfa, which are utilized in dairying and in pig farming. The soils on the steeper slopes are used as pasture or woodland.

A high water table in low areas and the hazard of erosion on the steeper slopes are the main limitations to farming these soils. The soils have good to fair suitability for use as pasture and woodland. Wetness, frost action, and low strength are the main limitations if the soils are used for building site development.

Nearly level to steep soils that formed in loamy, calcareous glacial till under savanna vegetation

These are loamy soils on ground moraines and drumlin fields. The soils are well drained and moderately well drained.

9. Holdingford-Growton Association

Nearly level to sloping, well drained and moderately well drained, moderately coarse textured soils on uplands

The soils making up this association are on nearly level to sloping ground moraines and drumlin fields. The rises and ridges generally have long, smooth, uniform slopes that are dissected by long, narrow drainageways and randomly scattered depressions. The slopes range from 1 to 15 percent.

This association makes up about 3 percent of the total land area of Stearns County. It is about 35 percent Holdingford soils, 30 percent Growton soils, and 35 percent soils of minor extent.

The Holdingford soils are well drained. They are gently sloping to sloping. They are on crests and side slopes of smooth, uniform ridges. Slopes are convex. The surface layer is very dark brown sandy loam, and the subsurface layer is dark grayish brown sandy loam. The subsoil is dark yellowish brown and brown sandy loam. The underlying material is yellowish brown sandy loam. The seasonal high water table is at a depth of more than 6 feet.

The Growton soils are moderately well drained. They are nearly level to gently sloping. They are on plane to slightly convex slopes on crests and side slopes of drumlins and on ground moraines. They have a black sandy loam surface layer and a dark grayish brown sandy loam subsurface layer. The subsoil is grayish brown, dark brown, and brown, mottled sandy loam. The underlying material is yellowish brown, mottled sandy loam. The seasonal high water table is at a depth of 3 to 5 feet.

The minor soils in this association are Cathro, Mahtomedi, and Prebish soils. Cathro and Prebish soils are very poorly drained; they are in depressions and drainageways. Mahtomedi soils are excessively drained; they are on undulating to very steep slopes.

The soils are used mainly for dairy farming. Corn, small grains, and alfalfa are the principal crops. Management concerns are controlling erosion, improving drainage on the wet soils, improving tilth, and maintaining fertility. The soils are well suited to use as pasture and woodland. They have good to fair suitability for building site development. The slope and frost action are the main limitations to the use of the soils as building sites or for sanitary facilities.

10. Koronis-Marcellon Association

Nearly level to steep, well drained and somewhat poorly drained, medium textured soils on uplands

The soils making up this association are on nearly level and gently sloping ground moraines that have occasional rolling and moderately steep to steep slopes. The soils are mainly on gentle rises and knolls that have short, mostly irregular slopes. The slopes range from 1 to 25 percent.

This association makes up about 8 percent of the county. It consists of about 45 percent Koronis soils, 10 percent Marcellon soils, and 45 percent soils of minor extent.

The Koronis soils are well drained. They are gently sloping to steep. They are on crests and summits that have convex side slopes. They have a very dark gray loam surface soil. The subsoil is dark yellowish brown sandy clay loam and brown and dark brown loam. The underlying material is light olive brown loam. The seasonal high water table is at a depth of more than 6 feet.

The Marcellon soils are somewhat poorly drained. They are nearly level. They are on the lower part of side slopes and slightly convex rises. They have a black loam surface layer and black and very dark gray loam subsurface layers. The subsoil is dark brown and brown, mottled sandy clay loam. The underlying material is light olive brown, mottled sandy loam. The seasonal high water table is at a depth of 1 foot to 3 feet.

The minor soils in this association are Cordova, Estherville, Flom, Glencoe, Hamel, Muskego, Roliss, and Sunburg soils. Cordova, Flom, Hamel, and Roliss soils are poorly drained and are nearly level. Estherville soils are well drained and somewhat excessively drained and are on moderately steep slopes. Glencoe and Muskego soils are very poorly drained and are in depressions and drainageways. Sunburg soils are well drained and are on sloping to steep slopes.

The soils are mainly cropped to corn, small grains, and alfalfa, which are used in dairy farming and in raising beef cattle and pigs. The steeper slopes are generally used as pasture.

Controlling erosion, removing excess water from the wet soils, and maintaining tilth and fertility are the main concerns in management. The soils have good to fair suitability for pasture and woodland. Wetness, frost action, and low strength are the main limitations if these soils are used for building site development.

11. Gonvick-Waukon Association

Nearly level to moderately steep, somewhat poorly drained to well drained, medium textured soils on uplands

The soils making up this association are on ground and end moraines that are mainly nearly level to undulating. In some places there are steeper slopes on knolls, hills, and side slopes along the numerous drainageways. The slopes range from 1 to 18 percent.

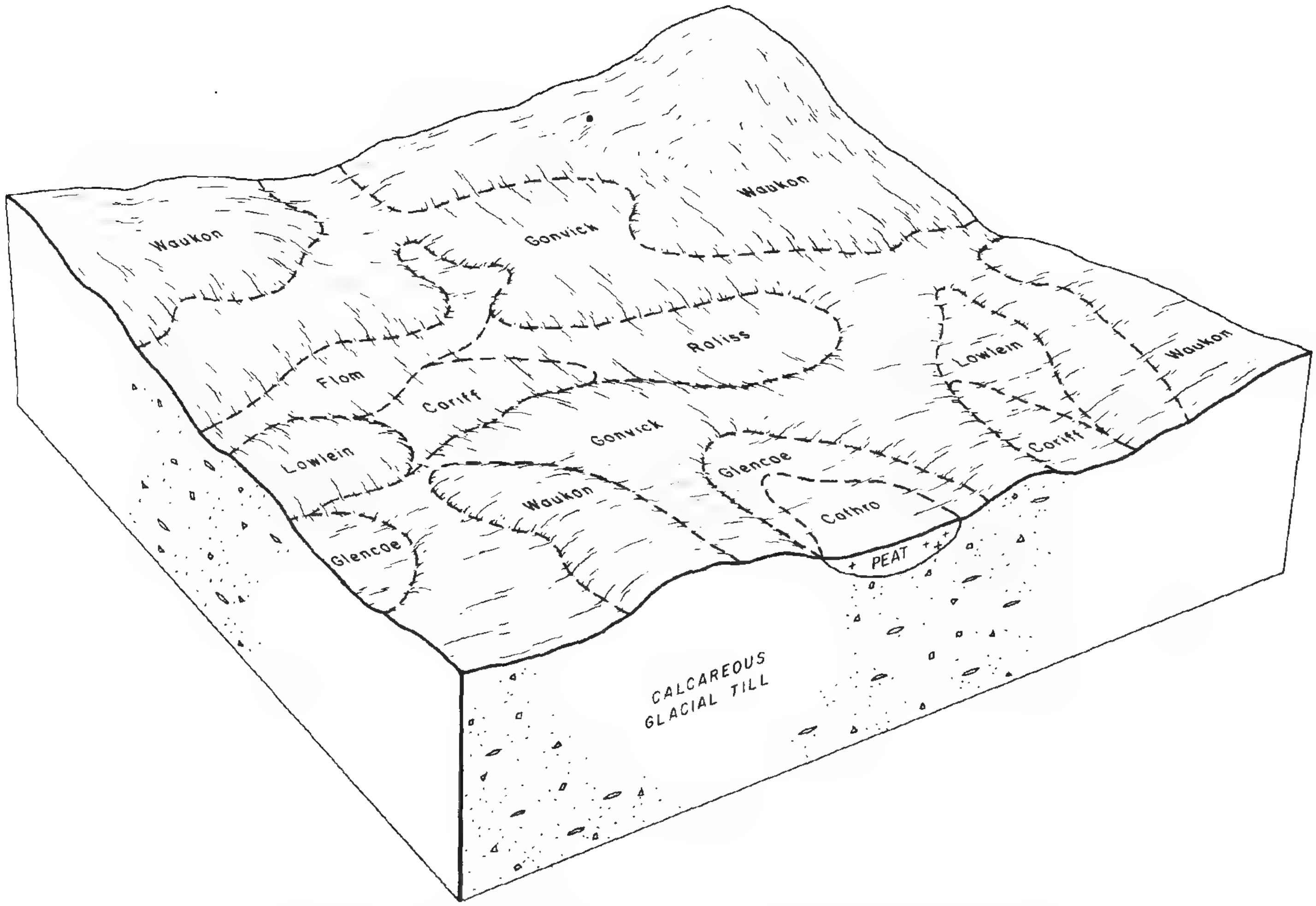


Figure 6—Pattern of soils and underlying material in the Gonvick-Waukon association.

This association makes up about 11 percent of the total land area of Stearns County. It is about 40 percent Gonvick soils, 35 percent Waukon soils and similar soils, and 25 percent soils of minor extent (fig. 6).

The Gonvick soils are moderately well drained and somewhat poorly drained; they are nearly level to gently undulating. They are on slight convex rises and flats and in gentle swales. They have a surface layer of black loam. The subsurface layer is also black loam. The subsoil is dark brown, dark grayish brown, and grayish brown, mottled clay loam. The underlying material is grayish brown and light olive brown, mottled loam. The seasonal high water table is at a depth of 2.5 to 6 feet.

The Waukon soils are well drained; they are gently sloping to moderately steep. They are mainly on crests and knolls and less commonly on moderately steep hills or side slopes. They have a surface layer of very dark gray loam and a subsoil of dark brown or brown and yellowish brown clay loam and loam. The underlying material is light olive brown and yellowish brown, mottled loam. The seasonal high water table is at a depth of more than 6 feet.

The minor soils in this association are Flom, Cathro, Coriff, Glencoe, Lowlein, and Roliss soils. The Cathro and Glencoe soils are very poorly drained and are in depressions and drainageways. The Coriff, Flom, and Roliss soils are poorly drained and are nearly level. The Lowlein soils are moderately well drained and are on broad flats and convex rises.

The soils in this association are intensively cropped. The main crops are corn, small grains, and alfalfa. The steeper slopes and the undrained wet soils are used as pasture.

Controlling erosion, removing excess water on wet soils, and maintaining tilth and fertility are the main concerns in management. The soils have fair to good suitability for use as pasture and woodland. If the soils

are used as building sites, the main limitations are wetness, frost action, low strength, and the moderate shrink-swell potential.

Nearly level to steep soils that formed in loamy, calcareous glacial till under prairie vegetation

These are loamy soils on ground and end moraines. The soils are well drained, moderately well drained, and poorly drained. They formed under prairie vegetation.

12. Ves-Normania Association

Nearly level to steep, well drained and moderately well drained, medium textured soils on uplands

The soils making up this association are mainly on sloping and rolling ground and end moraines. Undulating and moderately steep slopes are common. The soils are mainly on crests and side slopes of ridges and rolling knolls along major drainageways. The slopes are mainly 4 to 15 percent, but the range is from 1 to 25 percent.

This association makes up about 3 percent of the total land area of Stearns County. It consists of about 40 percent Ves soils, 30 percent Normania soils, and 30 percent soils of minor extent.

The Ves soils are well drained. They are undulating to steep and are on irregular knolls, hills, and ridges. They have a surface layer of black loam and a subsurface layer of very dark brown loam. The subsoil is dark brown loam. The underlying material is light olive brown, mottled loam. The seasonal high water table is at a depth of more than 6 feet.

The Normania soils are moderately well drained. They are nearly level to gently undulating and are on slight rises, low knolls, and broad, sunken tops of low hills. Slopes are slightly convex and concave. The soils have a surface layer of black loam and a subsurface layer of very dark brown loam. The subsoil is olive brown, mottled loam, and the underlying material is light olive brown, mottled loam. The seasonal high water table is at a depth of 3 to 6 feet.

The minor soils in this association are Estherville, Flom, Glencoe, and Storden soils. Estherville soils are somewhat excessively drained and are undulating to steep. Flom soils are poorly drained and are level. Glencoe soils are very poorly drained and are in depressions and drainageways. Storden soils are well drained and are sloping to moderately steep.

The soils in this association are used primarily for dairy farming. Corn, small grains, and alfalfa are the main crops. Controlling erosion and maintaining tilth and fertility are the main management concerns. A high water table in the low areas is also a limitation.

The soils are well suited to pasture, windbreaks, and building site development. The main limitations to their use as building sites are steep slopes, frost action, and the moderate shrink-swell potential.

13. Normania-Flom Association

Nearly level to undulating, moderately well drained and poorly drained, medium textured soils on uplands

The soils making up this association are on nearly level to undulating ground moraines that have broad, convex rises, on knolls, and in wet, flat draws and drainageways. The slopes are mainly 0 to 5 percent.

This association makes up about 15 percent of the total land area of Stearns County. It is about 40 percent Normania soils, 25 percent Flom soils, and 35 percent soils of minor extent (fig. 7).

The Normania soils are moderately well drained and are nearly level to undulating. They are on broad flats and low convex rises and in gentle swales. They have a surface layer of black loam and a subsurface layer of very dark brown loam. The subsoil is olive gray, mottled loam, and the underlying material is light olive brown, mottled loam. The seasonal high water table is at a depth of 3 to 6 feet.

The Flom soils are poorly drained. They are nearly level. They are in shallow drainageways and on broad, wet flats. The slope is plane to slightly concave. The surface layer is black loam, and the subsurface layer is black clay loam. The subsoil is olive gray, mottled clay loam, and the underlying material is light olive gray and olive gray, mottled loam. The seasonal high water table is at a depth of 1 foot to 2 feet.

The minor soils in this association are Cathro, Glencoe, Roliss, and Vallers soils. Cathro and Glencoe soils are very poorly drained. They are in depressions and drainageways. Roliss and Vallers soils are poorly drained. They are on ground moraines.

The soils are mainly intensively cropped. Corn, small grains, and alfalfa are the major crops. The steeper slopes and the undrained wet soils are used as pasture.

Removal of excess water on the wet soils and the maintenance of tilth and fertility are the main concerns in management. The soils are well suited to use as pasture, but they have fair to poor suitability for windbreaks and environmental plantings because of the seasonal high water table. They have fair to poor suitability for building site development because of wetness, frost action, low strength, and the moderate shrink-swell potential.

14. Roliss-Flom Association

Nearly level, poorly drained, medium textured soils on uplands

The soils making up this association are on nearly level ground moraines. The slopes range from 0 to 2 percent.

This association makes up about 4 percent of the total land area of Stearns County. It is about 30 percent Roliss soils, 20 percent Flom soils, and 50 percent soils of minor extent.

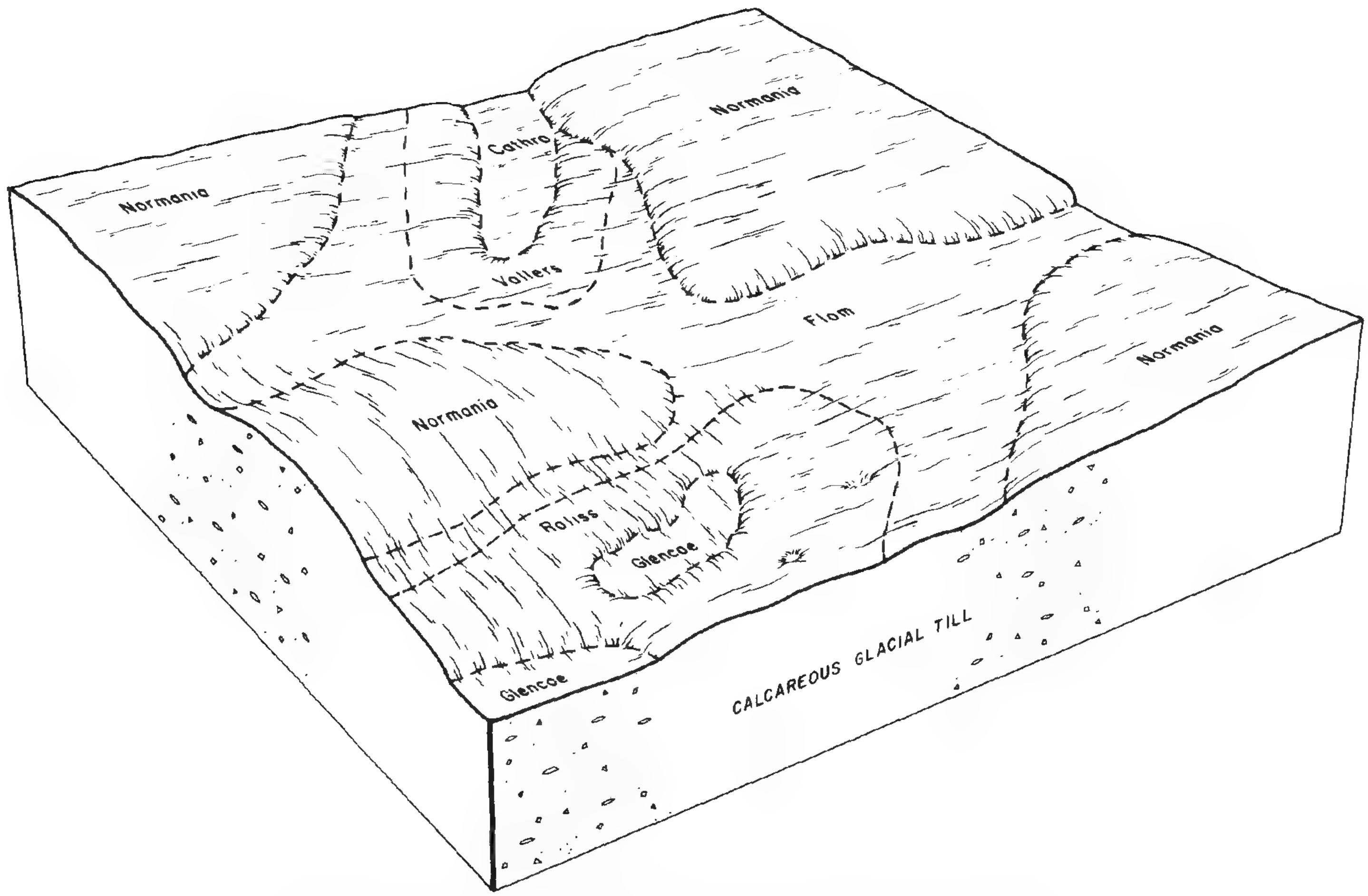


Figure 7.—Pattern of soils and underlying material in the Normania-Flom association.

The Roliss soils are poorly drained and are on broad, wet flats and near the rim of depressions. They have a surface layer of black loam and a subsurface layer of very dark gray loam. The subsoil is olive gray, mottled loam, and the underlying material is light olive gray and olive gray, mottled loam. The seasonal high water table is at a depth of 1 foot to 3 feet.

The Flom soils are poorly drained and are on broad, wet flats and in shallow drainageways. They have a surface layer of black loam and a subsurface layer of black clay loam. The subsoil is olive gray, mottled clay loam, and the underlying material is light olive gray and olive gray, mottled loam. The seasonal high water table is at a depth of 1 foot to 2 feet.

The minor soils in this association are Bluffton, Cathro, Coriff, Glencoe, Lowlein, Normania, and Vallers soils. Bluffton, Cathro, and Glencoe soils are very poorly drained and are in depressions and drainageways. Coriff and Vallers soils are poorly drained and are level. Lowlein and Normania soils are moderately well drained and are nearly level to undulating.

The soils in this association are mainly intensively farmed for cash crops and for feed for pigs and beef cattle. Corn, soybeans, small grains, and hay are the main crops.

Removal of excess water is the main concern in management. Maintaining tilth and fertility are also concerns. The soils are well suited to use as pasture, but they are poorly suited to windbreaks and environmental plantings because of the seasonal high water table. They are poorly suited to building site development because of wetness, low strength for supporting foundations, frost action, and the moderate shrink-swell potential.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Estherville sandy loam, 0 to 2 percent slopes, is one of several phases in the Estherville series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Estherville-Hawick complex, 2 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Histosols and Haplaquolls, ponded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

5A—Dakota loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on broad outwash plains, valley trains, and stream terraces. The areas vary in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark brown loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 7 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown and dark yellowish brown loam, and the lower part is yellowish brown sandy loam. The underlying material is yellowish brown sand and gravelly coarse sand to a depth of at least 60 inches. In some areas, the subsoil has less clay. Also, in some places, the depth to the sandy underlying material is less than 20 inches.

Included with this soil in mapping and making up 2 to 10 percent of the mapped areas are small areas of Biscay, Cylinder, Dorset, and Estherville soils. Biscay soils are poorly drained; they are in wet depressions and drainageways. Cylinder soils are somewhat poorly drained; they are on flats and in slightly concave areas. Dorset and Estherville soils are somewhat excessively drained; they are on knolls in areas where the loamy

mantle is thinner. They are more gravelly than the Dakota soil.

Permeability is moderate in the loamy mantle and rapid in the underlying material. The available water capacity is moderate to high. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow to medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is mainly used for crops. It is well suited to corn, small grains, and forage grasses and legumes. The soil is somewhat droughty because its available water capacity is moderate, but if irrigated it is highly productive. Conservation tillage, returning crop residue to the soil, and applying manure help increase the available water capacity, reduce evaporation, and help maintain tilth and fertility. Liming increases the effectiveness of fertilizers and improves stands of grasses and legumes.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to windbreaks and environmental plantings. Only those trees and shrubs that withstand droughty conditions should be selected for planting. Cultivation or herbicides help to control competing vegetation, including weeds.

The soil is well suited to building site development. Constructing roads on well compacted, coarse textured base material helps to prevent damage resulting from low strength and frost action. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIs.

5B—Dakota loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on undulating knolls and concave side slopes on broad outwash plains, valley trains, and stream terraces. The areas vary in shape and range from 5 to 25 acres in size.

Typically, the surface layer is very dark brown loam about 9 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil is about 31 inches thick. The upper part is dark yellowish brown and yellowish brown silt loam, and the lower part is dark yellowish brown and yellowish brown sandy loam and coarse sand. The underlying material is light yellowish brown gravelly coarse sand to a depth of at least 60 inches. In some areas, the subsoil has less clay. Also, in some places, the sandy underlying material is at a depth of less than 20 inches.

Included with this soil in mapping and making up 2 to 10 percent of the mapped areas are small areas of Biscay, Cylinder, Dorset, and Estherville soils. Biscay soils are poorly drained; they are in wet depressions and drainageways. Cylinder soils are somewhat poorly drained; they are on flats and in slightly concave areas. Dorset and Estherville soils are somewhat excessively drained; they are on undulating knolls and concave slopes in areas where the loamy mantle is thin. Also, they are more gravelly than the Dakota soil.

Permeability is moderate in the loamy mantle and rapid in the underlying material. The available water capacity is moderate. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow to medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Erosion is the main concern in management. This soil is somewhat droughty because its available water capacity is moderate, but if irrigated it is highly productive. Field stripcropping, crop rotation, and grassed waterways reduce soil loss and conserve moisture. Conservation tillage, return of crop residue, and applications of manure help increase the available water capacity and reduce evaporation and the hazard of erosion. Applications of lime increase the effectiveness of fertilizers and improve legume stands.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to windbreaks and environmental plantings. Only those trees and shrubs that are tolerant of droughty conditions should be selected for planting. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to building site development. Constructing roads on well compacted, coarse textured base material helps prevent damage resulting from low strength and frost action. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is installed in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIe.

7A—Hubbard loamy sand, 0 to 2 percent slopes. This is a nearly level, excessively drained soil on broad flats on outwash plains. The areas vary in shape and range from 5 to 200 acres in size.

Typically, the surface layer is black loamy sand about 7 inches thick. The subsurface layer is very dark grayish brown loamy sand and is also about 7 inches thick. The subsoil is about 34 inches thick. The upper part is dark brown and brown sand, and the lower part is yellowish brown sand. The upper part of the underlying material is yellowish brown, mottled sand, and the lower part is light yellowish brown, noncalcareous sand to a depth of at least 60 inches. In some places, the surface soil is more than 22 inches thick. In some areas, the depth to lime is less than 50 inches. Also, in some areas, the subsoil has more gravel in concentrated layers. In some places there are layers of finer textured material in the subsoil and underlying material.

Included with this soil in mapping and making up 5 to 8 percent of the map unit are small areas of Dickman and Estherville soils. Dickman and Estherville soils have more clay in the surface layer and subsoil; they and the Hubbard soil are in similar positions on the landscape.

Permeability is rapid, and the available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is poorly suited to corn, soybeans, and other late-maturing crops. Early-maturing crops, such as winter rye, do fairly well. In most years, crop growth is greatly reduced by drought. Only deep-rooted grasses and legumes can make any sustained growth on this soil. Management practices that help overcome droughtiness and maintain fertility are needed. Minimum tillage or a winter cover crop helps conserve moisture and prevent soil blowing. A balanced fertilization program, liming, applying manure, and returning crop residue help improve fertility. Irrigation can minimize the hazard of drought. Crops respond well to irrigation. Center pivot and traveling gun irrigation systems are the types most commonly used.

The soil is well suited to use as pasture. The main limitation is the hazard of drought. Overgrazing reduces the protective cover and causes the plant community to deteriorate as the less desirable species increase. Pasture rotation, proper fertilization, liming, weed control, and proper stocking rates help establish and maintain a desirable plant community for forage production. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetative cover should be left to reduce soil blowing while young trees are becoming established. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is fairly suited to use as woodland. The main limitation is seedling mortality caused by droughtiness and soil blowing. Droughtiness can be partly overcome by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Injury to young plants by soil blowing can be reduced by mulching around the seedlings and maintaining vegetative cover on adjacent fields. Replacement of some seedlings may be necessary.

The soil is well suited to building site development. It readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. On septic tank absorption fields there should be at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous, sandy material. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IVs and in woodland suitability group 3s.

7B—Hubbard loamy sand, 2 to 6 percent slopes. This is a gently sloping, excessively drained soil on crests and side slopes on outwash plains. The areas vary in shape and range from 5 to 200 acres in size.

Typically, the surface layer is very dark brown loamy sand about 10 inches thick. The subsoil is about 40 inches thick. The upper part is dark brown loamy sand, the middle part is dark yellowish brown sand, and the lower part is dark yellowish brown loamy sand. The underlying material is light yellowish brown, noncalcareous coarse sand to a depth of at least 60 inches. In some areas, the surface soil is more than 22 inches thick. In some places, the depth to lime is less than 50 inches. Also, in some areas, there is gravel in concentrated layers in the subsoil. In places there are layers of finer textured material in the subsoil and underlying material.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Dickman, Duelm, and Isan soils. The moderately well drained Duelm soils are on flats and in slightly concave areas. The poorly drained Isan soils are in depressions and drainageways. The well drained Dickman soils are in swales. They have more clay in the surface layer and subsoil than the Hubbard soil.

Permeability is rapid, and the available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is poorly suited to corn, soybeans, and other late-maturing crops. Early-maturing crops, such as winter rye, do fairly well. In most years, crop growth is greatly reduced by drought. Only deep-rooting grasses and legumes can make any

sustained growth on this soil. Management practices that help overcome droughtiness and maintain fertility are needed. Minimum tillage or a winter cover crop helps conserve moisture and prevent soil blowing. A balanced fertilization program, liming, applying manure, and returning crop residue help improve fertility. Irrigation can minimize the hazard of drought. Crops respond well to irrigation. Center pivot and traveling gun irrigation systems are the types most commonly used.

The soil is fairly well suited to use as pasture, but drought is a hazard. Overgrazing reduces the protective cover and causes the plant community to deteriorate as the less desirable species increase. Pasture rotation, proper fertilization, liming, weed control, and proper stocking rates help establish and maintain a desirable plant community for forage production. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetative cover should be left to reduce soil blowing while young trees are becoming established. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is fairly suited to use as woodland. The main limitation is seedling mortality caused by droughtiness and soil blowing. Droughtiness can be partly overcome by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Injury to young plants by soil blowing can be reduced by mulching around the seedlings and maintaining vegetative cover on adjacent fields. Replacement of some seedlings may be necessary.

The soil is well suited to building site development. Buildings should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. The soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. On septic tank absorption fields, there should be at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous, sandy material. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IVs and in woodland suitability group 3s.

7C—Hubbard loamy sand, 6 to 12 percent slopes. This is a sloping, excessively drained soil on crests and convex side slopes on outwash plains. The areas vary in shape and range from 3 to 20 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 10 inches thick. The subsurface layer is very dark grayish brown loamy sand about 3 inches thick. The subsoil is about 35 inches thick. The upper part is brown and dark brown sand, the middle part is dark yellowish brown sand, and the lower part is dark brown and brown coarse sand. The underlying material is mottled, noncalcareous brown sand to a depth of at least 60 inches. In some areas, the surface soil is more than 22 inches thick; in others, it is less than 10 inches thick. In some places the surface soil and subsoil have more gravel. Also, in some areas, the depth to lime is less than 50 inches. In some places there are layers of finer textured material in the subsoil and underlying material. Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Dickman and Hawick soils. Dickman soils have more clay in the surface soil and subsoil than the Hubbard soil. They are in concave swales and drainageways. Hawick soils are excessively drained and are on the most exposed, convex part of rises and ridges.

Permeability is rapid, and the available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture. It is generally not suitable for use as cropland because of the hazards of drought and erosion. It is best suited to permanent plant cover. In areas where vegetation is sparse or absent, this soil is highly susceptible to erosion by wind and water. It is difficult to irrigate because of the steep slopes and the low available water capacity.

The soil is poorly suited to use as pasture. Its droughtiness limits the quantity and quality of forage that can be produced. Overgrazing reduces the protective cover and causes the plant community to deteriorate as the less desirable species become dominant. Pasture rotation, proper fertilization, liming, weed control, and proper stocking rates help maintain a suitable cover. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetative cover should be left to reduce soil blowing while young trees are becoming established. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is fairly suited to use as woodland. The main limitation is seedling mortality caused by droughtiness and soil blowing. Droughtiness can be partly overcome

by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Injury to young plants by soil blowing can be reduced by mulching around the seedlings and maintaining vegetative cover on adjacent fields. Replacement of some seedlings may be necessary.

The soil is suitable for building site development. Erosion is a severe hazard. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become contaminated. On septic tank absorption fields there should be at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous, sandy material. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass VIs and in woodland suitability group 3s.

25—Becker fine sandy loam. This is a nearly level, moderately well drained and well drained soil on flats and swales of bottom lands along major rivers. The areas vary in shape and range from 3 to 20 acres in size. This soil is subject to rare flooding.

Typically, the surface layer is very dark brown fine sandy loam about 16 inches thick. The subsurface layer is very dark grayish brown and dark brown fine sandy loam about 17 inches thick. The subsoil is about 14 inches thick. The upper part is dark yellowish brown loamy fine sand, and the lower part is dark brown loamy fine sand. The underlying material is yellowish brown fine sand to a depth of at least 60 inches.

Included with this soil in mapping and making up as much as 10 percent of the mapped areas are small areas of Hubbard and Kalmarville soils and of Udifluvents, frequently flooded. Hubbard soils are excessively drained and are in somewhat higher positions on the landscape than the Becker soil. Kalmarville soils are poorly drained and very poorly drained; they are on low bottoms next to the river in partly filled backwater areas and oxbows. Udifluvents, frequently flooded, are somewhat poorly drained and poorly drained; they are also on low bottoms next to the river, but they are in areas where water flows somewhat more swiftly during periods of flooding.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. The available water capacity is moderate. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of 4 to 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Management concerns are droughtiness, rare flooding, and maintenance of fertility and tilth. In places, artificial drainage is needed to lower the seasonal high water table and remove excess water. Late planting avoids most of the problems caused by wetness in early spring. Returning crop residue and applying manure improve fertility and tilth and help conserve moisture. Because the available water capacity is moderate, crops commonly display signs of stress when a drought occurs late in the growing season. Irrigation can minimize the effects of drought.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides can help control competing vegetation, including weeds.

This soil is not suitable for building sites or septic tank absorption fields because of flooding. Constructing roads on raised, well compacted fill material and providing adequate side ditches and culverts help prevent damage to the roads by flooding and frost action.

This soil is in capability subclass IIs.

32B—Nebish sandy loam, 2 to 8 percent slopes. This is an undulating, well drained soil on convex to concave knolls, side slopes, and head slopes on ground and end moraines. The areas vary in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 5 inches thick. The subsurface layer is dark grayish brown sandy loam about 7 inches thick. The subsoil is about 26 inches thick. The upper part is yellowish brown and dark brown sandy clay loam, and the lower part is dark brown and brown fine sandy loam. The underlying material is light olive brown, calcareous sandy loam to a depth of at least 60 inches. In some places the subsoil is thicker. Also, in some areas the surface layer is thicker. Small areas that have slopes of less than 2 percent or more than 8 percent are in some mapped areas.

Included with this soil in mapping and making up 5 to 15 percent of some mapped areas are small areas of Bluffton and Shooker soils. Shooker soils are poorly drained; they are in wet drainageways and depressions. Bluffton soils are very poorly drained; they are in depressions.

Permeability is moderate, and the available water capacity is high. The content of organic matter is low, and natural fertility is medium. Surface runoff is medium.

The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major problems are related to the hazard of erosion. Grassed waterways, placed where runoff concentrates, help prevent excessive soil loss. Conservation tillage, contour farming, stripcropping, crop rotation, and crop residue management also help to slow down runoff and therefore are effective in controlling erosion. Returning crop residue and applying manure to the soil help improve fertility, reduce crusting, and increase water infiltration and the available water capacity.

The soil is well suited to use as pasture. A close-growing plant cover slows runoff and reduces erosion. Proper fertilization, weed control, and pasture rotation help maintain a desirable plant community and increase forage production.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control the competing vegetation.

This soil is well suited to building site development. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around the foundation with suitable material also helps prevent structural damage. Constructing roads on well compacted, coarse textured fill material helps protect the roads from damage by frost action and by shrinking and swelling. This soil does not readily absorb effluent in a septic tank absorption field. Installing a larger than average field helps to overcome this limitation.

This soil is in capability subclass IIe and in woodland suitability group 2o.

32C—Nebish sandy loam, 8 to 15 percent slopes. This is a rolling, well drained soil on convex knolls and concave side slopes and in shallow swales on ground and end moraines. The individual areas vary in shape and range from 4 to 30 acres in size.

Typically, the surface layer is black sandy loam about 4 inches thick. The subsurface layer is dark grayish brown sandy loam about 5 inches thick. The subsoil is dark yellowish brown and yellowish brown sandy clay loam about 22 inches thick. The underlying material is light olive brown, calcareous fine sandy loam to a depth of at least 60 inches. In some areas the underlying material is noncalcareous and has less silt, and in some places it has less clay. In some areas the surface layer is thicker, and in some areas it is dark brown or dark yellowish brown sandy loam or sandy clay loam.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Cordova and Shooker soils. Shooker and Cordova soils are poorly drained; they are in small, wet drainageways.

Permeability is moderate, and the available water capacity is high. The content of organic matter is low, and natural fertility is medium. Surface runoff is medium to rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. The major management concerns are related to the hazard of erosion. On slopes that are long and smooth enough, contour farming and stripcropping can be used to control erosion. Crop rotation, conservation tillage, and crop residue management also help control erosion and retard runoff. Returning crop residue and applying barnyard manure to the soil help improve fertility, reduce crusting, and increase water infiltration and the available water capacity.

The soil is well suited to use as pasture. A close-growing cover slows runoff and reduces erosion. Proper fertilization, weed control, and pasture rotation help maintain a desirable plant community and produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control the competing vegetation, including weeds.

This soil is suitable for building site development. Erosion, however, is a hazard during construction. Buildings should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around the foundation with suitable material also helps prevent structural damage. Roads constructed on this soil should be placed on the contour, if possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. Using well compacted, coarse textured base material helps prevent damage to roads by frost action and by shrinking and swelling. Because of the moderate permeability, this soil does not readily absorb the effluent from septic tank absorption fields. Also, slope is a limitation. Installing a larger than average field and placing distribution lines on the contour help overcome the limitations.

This soil is in capability subclass IIIe and in woodland suitability group 2o.

32E—Nebish sandy loam, 15 to 25 percent slopes. This is a hilly to steep, well drained soil on convex hills

and hillsides on ground and end moraines. The areas vary in shape and range from 3 to 25 acres in size.

Typically, the surface layer is very dark brown fine sandy loam about 5 inches thick. The subsurface layer is dark grayish brown fine sandy loam about 5 inches thick. The subsoil is dark yellowish brown and yellowish brown sandy clay loam about 24 inches thick. The underlying material is yellowish brown, calcareous sandy loam to a depth of at least 60 inches. In some places, the dark subsurface layer is thicker. In some areas, the underlying material is noncalcareous and has less silt.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Bluffton and Cordova soils. The poorly drained Cordova soils are in drainageways and swales. The very poorly drained Bluffton soils are in depressions.

Permeability is moderate, and the available water capacity is high. The content of organic matter is low, and natural fertility is medium. Surface runoff is rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture. Overgrazing can cause surface compaction, excessive runoff, and poor tilth. Proper fertilization, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage. This soil is not suited to row crops and small grains because of the steep slopes and the hazard of erosion.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Water erosion is a severe hazard unless the soil is kept vegetated; site preparation should be limited to the area within 2 feet of the planting. Cultivation or herbicides help control competing vegetation, including weeds.

The soil is well suited to use as woodland. The steep slopes limit the use of equipment. The main concerns are plant competition, droughtiness on south- and west-facing slopes, and the hazard of erosion. Cutting, spraying, girdling, and prescribed burning help control competing vegetation. Mulching, timely planting, selecting only those species for planting that withstand drought, and planting on north- and east-facing slopes all help to reduce seedling mortality caused by droughtiness. Erosion can be controlled by maintaining an adequate ground cover.

Slope is a limitation to the use of this soil for building sites. Erosion is a severe hazard during construction. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Extensive cuts and fills generally are needed if roads are built on this soil. Roadbanks should be planted to well-adapted grasses to minimize erosion. Land shaping, enlarging the absorption field area, and placing the distribution lines on the contour generally are necessary for proper operation of a septic tank absorption system.

This soil is in capability subclass VIe and in woodland suitability group 2r.

32F—Nebish sandy loam, 25 to 40 percent slopes. This is a very steep, well drained soil on bluffs and valley walls on ground and end moraines. The individual areas vary in shape and range from about 3 to 30 acres in size.

Typically, the surface layer is black sandy loam about 3 inches thick. The subsurface layer is brown sandy loam about 6 inches thick. The subsoil is dark yellowish brown sandy clay loam about 15 inches thick. The underlying material in the upper part is yellowish brown, calcareous sandy loam; in the lower part it is light olive brown, calcareous sandy loam to a depth of 60 inches or more. In some places the subsoil is thicker, and the depth to calcareous sandy loam till is greater. In some areas, the underlying material has more clay.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Storden soils. They are on steeper slopes, show very little soil development, and have calcareous till near the surface.

Permeability is moderate. The available water capacity is high. The content of organic matter is low, and natural fertility is medium. Surface runoff is rapid. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is presently idle or is not used. In some areas it is in permanent pasture, although it is poorly suited to use as pasture. A close-growing plant cover is needed to control erosion and runoff. Overgrazing can cause surface compaction, excessive runoff, and poor tilth. Proper pasture management helps reduce runoff and increase forage production. This soil is not suitable for use as cropland because of the very steep slopes.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Water erosion is a severe hazard unless the soil is kept vegetated; site preparation should be limited to the area within 2 feet of the plantings. Cultivation or herbicides help control competing vegetation, including weeds.

The soil is well suited to use as woodland. The steep slopes limit the use of equipment. The main concerns are plant competition, droughtiness on south- and west-facing slopes, and the hazard of erosion. Cutting, spraying, girdling, and prescribed burning help control competing vegetation. Mulching, timely planting, selecting only those species for planting that withstand drought, and planting on north- and east-facing slopes all help to reduce seedling mortality caused by droughtiness. Erosion can be controlled by maintaining an adequate ground cover.

Slope is a limitation to the use of this soil for building sites. Erosion is a severe hazard during construction. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope. Extensive cuts and fills generally are needed in constructing roads on this soil. Roadbanks should be planted to well-adapted grasses to minimize erosion.

Because of the very steep slopes, this soil is not suitable for septic tank absorption fields.

This soil is in capability subclass VIIe and in woodland suitability group 2r.

35—Blue Earth mucky silt loam. This is a level, very poorly drained soil in shallow lake basins and deep depressions. The areas vary in shape and range in size from 5 to 150 acres. This soil is subject to ponding.

Typically, this soil has a black, calcareous mucky silt loam surface layer 6 inches thick. The underlying material is very dark gray and black mucky silt loam and silt loam to a depth of at least 60 inches. In some places, there is a surface layer of muck as much as 12 inches thick. In some areas, there is loamy glacial till above a depth of 30 inches.

Permeability is moderate to moderately slow. The available water capacity is high to very high. The content of organic matter is high, and natural fertility is medium. Surface runoff is very slow or is ponded. The water table is at or near the surface throughout the year.

In most areas this soil is used for corn, small grains, and forage grasses and legumes. It is fairly well suited to use as cropland. Wetness, fertility problems, and soil blowing are the main concerns in management. Wetness and ponding can be controlled by a combination of surface and subsurface drains. Drainage permits earlier planting and helps prevent damage to crops by ponding. In some places, the content of lime in the surface layer is high enough to cause a fertility imbalance. Maintaining a proper balance of nutrients by adding fertilizers can minimize lodging of small grains and permit corn to reach maturity. Returning crop residue to the soil and leaving plowed fields rough and cloddy help minimize soil blowing.

The soil is fairly well suited to use as pasture. Artificial drainage is needed to ensure that excess water does not hinder plant growth. Proper stocking rates, pasture rotation, timely deferment of grazing, fertilization, and restricted use during wet periods help establish and maintain grasses suitable for high forage production.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe. Cultivation or herbicides can help control competing vegetation, including weeds.

The soil is well suited to development as habitat for wetland wildlife. Impoundments can be readily constructed to create areas of open water for waterfowl and aquatic wildlife.

This soil is generally not suitable for building sites or septic tank absorption fields because of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads resulting from ponding, frost action, and low soil strength.

This soil is in capability subclass IIIw.

36—Flom loam. This is a nearly level, poorly drained soil in shallow drainageways and on broad flats on ground moraines. The areas vary in shape and range from 3 to 80 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is black clay loam about 8 inches thick. The subsoil is olive gray, mottled clay loam about 7 inches thick. The underlying material is light olive gray and olive gray, mottled, calcareous loam to a depth of at least 60 inches. In some places, there is an accumulation of lime below a depth of 16 inches. Also, in some areas there is lime in the surface soil. In some places the dark surface layer is more than 20 inches thick.

Included with this soil in mapping and making up 10 percent of the map unit are small areas of the moderately well drained Normania soils, which are on knolls and slight rises.

Permeability is moderately slow. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling wetness and maintaining fertility are concerns in management. Open ditches and subsurface drainage lines can adequately draw excess water from the soil where suitable outlets are available. Applying fertilizer and manure helps maintain or improve fertility and helps increase yields.

The soil is well suited to use as pasture. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, fertilization, and restricted use during very wet periods help to maintain a stand of desirable grasses and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides can help control competing vegetation, including weeds.

The soil is poorly suited to building site development because of wetness. Buildings on this soil should be built without a basement, and land shaping should be designed to drain surface water away from the building foundation. Tile drains around the foundation are necessary to remove excess subsurface water. Constructing roads on well compacted suitable fill material helps prevent damage caused by low soil strength and frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw.

38B—Waukon loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on knolls and convex side slopes on ground and end moraines. The areas vary in shape and range in size from 5 to 50 acres.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown clay loam, and the lower part is brown loam. The underlying material is light olive brown, calcareous loam to a depth of at least 60 inches. In some areas, the subsoil is less developed and has weaker structure. Also, in some places the dark surface layer is thicker than is typical.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of the poorly drained Cordova soils, which are in drainageways and wet, concave swales.

Permeability is moderate. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling erosion and maintaining fertility are the main concerns in management. Conservation tillage, returning crop residue to the soil, and proper crop rotation are effective in controlling erosion. Grassed waterways are needed to prevent gullying.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help maintain desirable grasses for high forage production.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help to control competing plants, including weeds.

The soil is well suited to building site development. If buildings are constructed on this soil, foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around the foundation with suitable coarse material also helps prevent structural damage. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action and by shrinking and swelling. This soil does not readily absorb the effluent in a septic tank absorption field because of its moderate permeability. Installing a larger than average field helps overcome this limitation.

This soil is in capability subclass IIe and in woodland suitability group 2o.

38C—Waukon loam, 6 to 12 percent slopes. This is a sloping, well drained soil on crests and convex side slopes on ground and end moraines. The areas vary in shape and range in size from 3 to 30 acres.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is about 22 inches thick. The upper part is brown clay loam, and the lower part is light olive brown, calcareous loam. The underlying material is light olive brown, calcareous loam to a depth of at least 60 inches. In some areas, the subsoil is less developed and has weaker structure. Also, in some places the dark surface layer is thicker than is typical.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of the poorly drained Cordova soils, which are in drainageways and wet, concave swales.

Permeability is moderate. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. Controlling erosion, maintaining fertility, and conserving moisture are the main concerns in management. Conservation tillage, returning crop residue to the soil, and proper crop rotation conserve moisture and reduce soil loss. Grassed waterways are needed to prevent gullying.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help maintain desirable grasses for high forage production.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help to control competing plants, including weeds.

The soil is suitable for building site development. Erosion is a hazard during construction. Buildings should be designed to conform to the natural slope. Land shaping may be needed in some areas. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around the foundation with suitable coarse material also helps prevent structural damage. Roads constructed on this soil should be placed on the contour wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. Using well compacted, coarse textured base material helps prevent damage to the roads by frost action and by shrinking and swelling. Because of the moderate permeability, this soil does not readily absorb effluent in a septic tank absorption field. Also, slope is a limitation. Installing a larger than average absorption field and placing the distribution lines on the contour help to overcome the limitations.

This soil is in capability subclass IIIe and in woodland suitability group 2o.

38D—Waukon loam, 12 to 18 percent slopes. This is a moderately steep, well drained soil on summits and hillsides on ground and end moraines. The areas vary in shape and range in size from 3 to 15 acres.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is about 21 inches thick. The upper part is dark brown and brown clay loam, and the lower part is yellowish brown loam. The underlying material is light olive brown and yellowish brown, calcareous loam to a depth of 60 inches or more. In some areas, the subsoil is less developed and has weaker structure. Also, in some places the dark surface layer is thicker than is typical.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of the poorly drained Cordova soils, which are in drainageways and wet, concave swales.

Permeability is moderate. The available water capacity is high. Natural fertility is high, and the content of organic matter is moderate. Surface runoff is rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture. In some areas it is used for crops. This soil is poorly suited to corn and small grains, because erosion is a severe hazard. Controlling erosion, maintaining fertility, and conserving moisture are the main concerns in management. Conservation tillage, grassed waterways, close-growing cover crops, and a proper crop rotation help conserve moisture and reduce soil loss. A balanced fertilization program, applying manure, and returning crop residue to the soil help establish alfalfa and improve yields of other crops. Grassed waterways and terraces are needed to prevent gullying.

The soil is well suited to use as pasture. However, overgrazing causes the plant community to deteriorate as undesirable nuisance species increase. Proper stocking rates, pasture rotation, fertilization, and weed control help maintain high production of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Water erosion is severe unless the soil is kept vegetated; site preparation should be limited to the area within 2 feet of the plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. The moderately steep slopes limit the use of equipment. Other major concerns are plant competition, droughtiness on south- and west-facing slopes, and the hazard of erosion. Cutting, spraying, girdling, and prescribed burning can control competing vegetation. Mulching, timely planting, planting only those species that withstand drought, and planting on north- and east-facing slopes help reduce seedling mortality caused by droughtiness. Erosion can be controlled by maintaining an adequate ground cover.

Slope is a limitation to the use of this soil for building site development. Erosion is a severe hazard. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Extensive cuts and fills commonly are needed in road construction on this soil. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. Land shaping, installing a larger than average absorption field, and placing the distribution lines on the contour generally are necessary for the proper operation of a septic tank absorption system.

This soil is in capability subclass IVe and in woodland suitability group 2r.

41A—Estherville sandy loam, 0 to 2 percent slopes. This is a nearly level, somewhat excessively drained soil on broad flats and low, convex rises on outwash plains and stream terraces. The areas vary in shape and range from 5 to about 200 acres in size.

Typically, the surface layer is black sandy loam about 5 inches thick. The subsurface layer is very dark grayish brown sandy loam about 7 inches thick. The subsoil is dark yellowish brown and is about 12 inches thick. The upper part is sandy loam, and the lower part is loamy coarse sand. The underlying material is yellowish brown, calcareous gravelly coarse sand to a depth of at least 60 inches. In some places the depth to sand and gravel is less than 15 inches. Also, in some places the surface layer is lighter in color. In places, the subsoil has more clay.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Hawick and Regal soils. Hawick soils are excessively drained and are on the most exposed, convex part of rises and ridges. Regal soils are poorly drained and are in wet, concave swales.

Permeability is moderately rapid in the loamy mantle and rapid in the sandy underlying material. The available water capacity is low. The content of organic matter is moderate, and natural fertility is low. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

In most areas this soil is used for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. It is better suited to shallow-rooting, early-maturing crops because its low available water capacity carries a risk of droughtiness in summer. Management concerns are controlling erosion, conserving moisture, and maintaining fertility. Minimum tillage or a winter cover crop helps conserve moisture and protect the soil from blowing. A balanced fertilization program, applications of manure, and the return of crop residue to the soil help improve fertility. Irrigation can minimize the effects of drought. This soil is especially well suited to irrigated truck crops. Center pivot and traveling gun

irrigation systems are the types most commonly used. Crops respond well to irrigation.

The soil is well suited to use as pasture. The main management concern is the hazard of drought. Overgrazing reduces the protective cover and causes the plant community to deteriorate as undesirable nuisance species become established. Pasture rotation, proper fertilization, weed control, and proper stocking rates help to maintain the desirable pasture plants. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetative cover should be left to reduce soil blowing while young trees are becoming established. Weeds and other competing vegetation can be controlled by cultivation or herbicides.

The soil is well suited to building site development. It readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should have at least 6 inches of sandy loam or loam between the point where the effluent enters the soil and the underlying porous, sandy layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIs.

41B—Estherville sandy loam, 2 to 6 percent slopes. This is a gently sloping, somewhat excessively drained soil on crests and side slopes of stream terraces and outwash plains. The areas vary in shape and range from 4 to 40 acres in size.

Typically, the surface layer is black sandy loam about 5 inches thick. The subsurface layer is very dark brown sandy loam about 5 inches thick. The subsoil is dark brown sandy loam and dark yellowish brown loamy coarse sand and is about 8 inches thick. The underlying material is yellowish brown, brown, and pale brown, calcareous gravelly coarse sand to a depth of at least 60 inches. In some places the depth to sand and gravel is less than 15 inches. Also, in places the subsoil has more clay and is finer textured.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Hawick and Regal soils. Hawick soils are excessively drained; they are on the most exposed, convex part of rises and ridges. Regal soils are poorly drained and are in wet, concave swales.

Permeability is moderately rapid in the loamy mantle and rapid in the underlying material. The available water capacity is low. The content of organic matter is moderate, and the level of natural fertility is low. Surface runoff is slow to medium. The depth to the seasonal high water table is more than 6 feet.

In most areas this soil is used for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. The major problems are the low available water capacity, the hazard of wind erosion, and low fertility. Conservation tillage, applications of manure, return of crop residue to the soil, and winter cover crops reduce soil blowing, conserve moisture, and improve fertility and tilth. Early-maturing crops make better use of spring moisture. Irrigation can minimize the hazard of drought.

The soil is well suited to use as pasture. The major management concerns are droughtiness and plant competition. Overgrazing during the dry months reduces the protective cover and allows unwanted species to become established. Pasture rotation, fertilizing, weed control, and proper stocking rates help maintain the desirable plants. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during summer.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to building site development. It readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous, sandy layer. In some places a mound system can be installed: the absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIs.

41C—Estherville sandy loam, 6 to 12 percent slopes. This is a sloping, somewhat excessively drained soil on rolling knolls and concave side slopes on outwash plains and stream terraces. The areas vary in shape and range from 3 to about 25 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsoil is dark yellowish brown and is about 15 inches thick. The upper part is sandy loam, and the lower part is coarse sand. The underlying material is yellowish brown, calcareous coarse sand to a depth of at least 60 inches. In some places the depth to sand and gravel is less than 15 inches.

Also, in some places the subsoil has more clay and is finer textured than is typical. In some cultivated areas part of the surface layer has been lost through erosion.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Hawick and Regal soils. Hawick soils are excessively drained; they are on the most exposed, convex part of rises and ridges. Regal soils are poorly drained and are in wet, concave swales.

Permeability is moderately rapid in the loamy mantle and rapid in the sandy underlying material. The available water capacity is low. The content of organic matter is moderate, and natural fertility is low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

In most areas this soil is used for crops. However, it is poorly suited to row crops and small grains. The major management concerns are the hazard of erosion, the low natural fertility, and the low available water capacity of the soil. Conservation tillage, contour farming, applications of manure, the return of crop residue to the soil, and winter cover crops help to reduce erosion, to conserve moisture, and to maintain fertility, soil structure, and tilth. Early-maturing crops, such as small grains, make better use of spring moisture. A crop rotation that includes a grass-legume hay mixture significantly reduces the hazard of erosion.

This soil is fairly well suited to use as pasture. The major management concerns are droughtiness and plant competition. Overgrazing the pasture during the dry months reduces the protective cover and allows unwanted species to become established. Deferring grazing early in spring and late in fall allows the pasture plants to regain vigor and reduces losses by winterkill, trampling, and compaction. Pasture rotation, fertilizing, weed control, and proper stocking rates help maintain the desirable pasture plants. Permanent pasture of warm-season grasses produces more forage during the hot months than bluegrass, which is dormant in summer.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is suitable for building site development. Erosion is a severe hazard during construction. Buildings should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion.

This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IVs.

69B—Fedji loamy sand, 2 to 6 percent slopes. This is a gently sloping, somewhat excessively drained soil on crests and shoulder slopes on ground moraines. The individual areas vary in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark brown loamy sand about 9 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 3 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown fine sand, the middle part is dark yellowish brown fine sand, and the lower part is dark yellowish brown loam. The underlying material is light olive brown loam to a depth of at least 60 inches. In some areas, the dark surface soil is less than 10 inches thick. In some places, the subsoil has more clay. Also, in some places the sandy mantle is less than 20 inches thick, and in others it is more than 40 inches thick.

Included with this soil in mapping and making up 10 to 15 percent of most mapped areas are small areas of Duelm and Gonvick soils, which are moderately well drained. Duelm and Gonvick soils are in concave swales on flats. Also, Gonvick soils do not have a sandy mantle.

Permeability is rapid in the sandy layers and moderate in the lower part of the soil. The available water capacity is moderate to low. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. Management practices are mainly those that overcome droughtiness, maintain fertility, and control soil blowing. Minimum tillage or a winter cover crop helps conserve moisture and protect the soil from blowing. A balanced fertilization program, applying manure, liming, and returning crop residue to the soil help improve fertility. Irrigation can minimize the effects of drought.

The soil is well suited to use as pasture. The main limitation is droughtiness. Overgrazing reduces the protective cover and causes the plant community to deteriorate as less desirable plant species increase. Pasture rotation, proper fertilization, weed control, and proper stocking rates help to maintain productive grasses for forage. Permanent pasture of warm-season grasses produces good forage during the hot summer months when bluegrass is dormant.

The soil is well suited to windbreaks and environmental plantings. Only those trees and shrubs that withstand drought should be selected for planting. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Seedling mortality is moderate because the droughtiness of the sandy layers causes moisture stress in the seedlings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is well suited to building site development. Constructing roads on well compacted, coarse textured base material helps prevent damage resulting from low soil strength. The moderate permeability in the underlying material prevents this soil from readily absorbing the effluent from septic tank absorption fields. Installing a larger than average drain field helps overcome this limitation.

This soil is in capability subclass IIIs.

72—Shooker loam. This is a nearly level, poorly drained soil in slightly concave depressions and drainageways on uplands. The areas vary in shape and range from 3 to 20 acres in size.

Typically, the surface layer is dark gray loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 9 inches thick. The subsoil is dark grayish brown and olive gray, mottled loam about 21 inches thick. The underlying material is olive gray, mottled, calcareous loam to a depth of at least 60 inches. In some places the subsoil is thicker than is typical, and calcareous loam till is at a greater depth. In some areas the soil is more poorly drained. Also, in some areas the surface layer is darker and thicker than is typical, and in some places it has more sand.

Included with this soil in mapping and making up about 5 to 10 percent of some mapped areas are small areas of Beltrami soils. Beltrami soils are moderately well drained. They are on slight rises and are slightly more sloping than the Shooker soil.

Permeability is moderate. The available water capacity is high. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Crop varieties that tolerate prolonged wetness should be selected for planting. Wetness is the major limitation, and adequate artificial drainage is needed for the highest yields. If this soil is worked when it is wet, it becomes cloddy and hard upon drying. Returning crop residue to the soil and applying manure help maintain tilth, which is important in preparing a good seedbed and in providing optimum conditions for plant growth. Liming increases the effectiveness of fertilizers and improves legume stands.

This soil is well suited to use as pasture. Wetness can be overcome by proper drainage. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper fertilization, liming, pasture rotation, weed control, and restricted use during wet periods help to maintain a desirable plant community and to produce high yields of forage.

This soil is well suited to windbreaks and environmental plantings. However, only those trees and shrubs that can tolerate wetness should be selected for planting. Wetness causes moderate seedling mortality and can delay spring planting. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is well suited to use as woodland. The main concerns are seedling mortality caused by wetness and plant competition. Only species that tolerate wetness should be planted. Site preparation and cultivation of the soil and cutting, spraying, girdling, or prescribed burning control plant competition.

This soil is poorly suited to use as a site for buildings because of wetness. Buildings on this soil should be built without a basement. Land shaping should be designed to drain surface water away from the building foundation. Tile drains around the foundation help remove excess subsurface water. Constructing roads on well compacted, coarse textured fill material reduces structural damage caused by frost action. This soil is poorly suited to use as septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw and in woodland suitability group 2w.

75—Bluffton loam. This is a nearly level, very poorly drained soil in shallow depressions and drainageways on ground moraines. The individual areas vary in shape and range from 3 to 10 acres in size. This soil is subject to ponding.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is also black loam and is about 9 inches thick. The subsoil is dark grayish brown, mottled clay loam about 14 inches thick. The underlying material is olive gray, mottled, calcareous loam to a depth of at least 60 inches. In some areas there is a muck layer at the surface as much as 16 inches thick. In some places there are layers of sand and gravel in the subsoil.

Permeability is moderately slow. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is very slow or is ponded. The water table is within 2 feet of the surface throughout the year.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. It is important to select crop varieties that tolerate prolonged wetness, as some may drown out or be short-lived. Excess water and fertility levels are the main concerns in management. Wetness and ponding can be controlled by artificial drainage. Where outlets are available, open ditches and subsurface drains can remove excess water to permit earlier planting of crops. Maintaining a proper balance of nutrients by adding fertilizers can minimize lodging of small grains and permit corn to reach maturity.

The soil is fairly well suited to use as pasture if it is adequately drained. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, fertilization, liming, and restricted use during wet periods help establish and maintain grasses that produce high yields of forage.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to development as habitat for wetland wildlife. Impoundments can be constructed to flood shallow excavated ponds for migratory waterfowl and elongated ditches for furbearers.

The soil is not suitable for building sites or septic tank absorption fields because of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding and frost action.

This soil is in capability subclass IIIw.

109—Cordova loam. This is a nearly level, poorly drained soil on concave surfaces, in drainageways and low-lying areas, and on broad, wet flats on ground moraines. The areas vary in shape and range from 5 to 30 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 3 inches thick. The subsoil is about 28 inches thick. The upper part is dark grayish brown, mottled clay loam, and the lower part is olive gray, mottled clay loam and loam. The underlying material is olive, mottled loam to a depth of at least 60 inches. In some places, the subsoil is less developed and has weaker structure. In some areas the soil is very poorly drained. Also, in some areas the dark surface soil is more than 24 inches thick.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Gonvick and Marcellon soils, which are moderately well drained. Gonvick and Marcellon soils are in higher positions on the landscape than the Cordova soil.

Permeability is moderately slow. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. It is important to select crop varieties that tolerate prolonged wetness. Controlling wetness and maintaining fertility are concerns in management. Open ditches and subsurface tile lines can adequately drain excess water from this soil if suitable outlets are available. Applying fertilizers and manure helps to maintain or improve fertility and to increase yields.

The soil is well suited to use as pasture. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, fertilization, and restricted use during very wet periods help maintain desirable grasses for high forage production.

The soil has fair suitability for windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Wetness causes moderate seedling mortality and may delay spring planting. Weed control by cultivation or by herbicides helps to remove competing vegetation.

The soil has fair suitability for use as woodland. The main concerns are seedling mortality caused by wetness and plant competition. Seedling mortality can be lessened by planting only those species that tolerate wetness. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help to control plant competition.

This soil is poorly suited to use as building sites because of wetness. Buildings on this soil should be built without a basement. Land shaping should be designed to drain surface water away from the building. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads caused by low strength and frost action. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the moderately slow permeability prevents the soil from readily absorbing effluent.

This soil is in capability subclass IIw and in woodland suitability group 3w.

114—Glencoe loam. This is a nearly level, very poorly drained soil in depressions. The areas vary in shape and range from 3 to 15 acres in size. This soil is subject to ponding.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is black, mottled loam and silty clay loam and is about 32 inches thick. The subsoil is olive gray, mottled silty clay loam about 14 inches thick. The underlying material is grayish brown, mottled loam to a depth of at least 60 inches. In some

places, the surface soil is less than 14 inches thick or more than 46 inches thick. In some areas, the subsoil has a higher content of clay than any part of the surface soil. Also, in some places there is as much as 16 inches of muck on the surface. In places the solum is calcareous.

Permeability is moderately slow to moderate. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow or is ponded. The seasonal high water table is within 1 foot of the surface.

This soil is used mainly for crops. With proper management, it is fairly well suited to corn, small grains, and forage grasses and legumes. Selecting crop varieties that tolerate prolonged wetness is important, because some kinds drown out or are short-lived. Excess water and maintenance of fertility are the main concerns in management. Wetness and ponding can be controlled by open ditches and subsurface drainage lines where outlets are available. Removing excess water permits earlier planting of crops.

This soil is fairly well suited to use as pasture if it is adequately drained. Grazing when the soil is ponded or wet, as well as overgrazing, causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, fertilization, and restricted use during wet periods help establish and maintain an adequate stand of desirable and productive forage grasses.

This soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is well suited to development as habitat for wetland wildlife. Impoundments can be constructed to flood shallow excavated ponds for migratory waterfowl and elongated ditches for furbearers.

This soil is not suitable for building sites or septic tank absorption fields because of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads resulting from ponding, frost action, and low soil strength.

This soil is in capability subclass IIIw.

119B—Pomroy fine sand, 1 to 8 percent slopes. This is a nearly level to gently sloping, well drained and moderately well drained soil on crests and side slopes on ground moraines. The individual areas vary in shape and range from 5 to 160 acres in size.

Typically, the surface layer is dark brown fine sand about 9 inches thick. The subsoil is about 30 inches thick. The upper part is brown fine sand. The lower part is dark brown, mottled gravelly loamy fine sand and sandy loam. The underlying material is dark brown, noncalcareous sandy loam to a depth of at least 60 inches.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Brainerd, Mahtomedi, and Watab soils. Brainerd soils are moderately well drained; they are on gentle, convex slopes, and they do not have a sandy mantle. Mahtomedi soils are excessively drained; they are on the steeper part of outwash landscapes adjacent to areas of glacial till. Watab soils are somewhat poorly drained; they are in concave draws and small depressions.

Permeability is rapid in the sandy mantle and is moderately slow in the lower part of the subsoil and the underlying material. The available water capacity is moderate. The content of organic matter and natural fertility are low. Surface runoff is slow to medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. It is droughty in dry spells, and if cultivated it is subject to wind erosion. A cropping system that conserves moisture and increases the content of organic matter is needed. Field shelterbelts and wind stripcropping help to reduce wind erosion. A balanced fertilizer program, applying manure, and returning crop residue to the soil improve fertility and tilth. Liming increases the effectiveness of fertilizers and improves legume stands. Irrigation can minimize the effects of drought.

The soil is fairly well suited to use as pasture. Adequate liming, fertilizing, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of nutritious forage. Permanent pasture of such warm-season grasses as sideoats grama, green needlegrass, and little bluestem provides good forage during the hot summer months when bluegrass is dormant. Deferring grazing early in spring and late in fall allows the pasture plants to regain vigor and reduces losses from winterkill.

The soil has fair suitability for windbreaks and environmental plantings. Only those trees and shrubs that withstand droughty conditions should be selected for planting. Some vegetation should be left on the soil to reduce soil blowing while young trees are becoming established. Seedling mortality is moderate because droughtiness can cause moisture stress in the seedlings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil has fair suitability for use as woodland. The main limitation is seedling mortality caused by droughtiness and by soil blowing. Droughtiness can be partly offset by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining vegetative cover on adjacent

fields. Replacement of some seedlings may be necessary.

This soil is well suited to building site development and to local roads. The moderately slow permeability in the lower part of the soil retards the absorption of effluent from septic tank absorption fields. A larger than average drain field helps overcome this limitation.

This soil is in capability subclass IIIs and in woodland suitability group 2s.

125—Beltrami loam. This is a nearly level to undulating, moderately well drained and somewhat poorly drained soil on ground and end moraines. It is on plane or slightly convex heads of drainageways. The areas vary in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. The subsurface layer is dark grayish brown and grayish brown loam and is about 9 inches thick. The subsoil is light olive brown, mottled loam and clay loam and is about 20 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places, the subsoil is thicker, and the depth to calcareous loam till is greater. In some areas, the surface layer is darker in color.

Included with this soil in mapping and making up 5 to 10 percent of some mapped areas are small areas of Bluffton, Glencoe, Nebish, and Shooker soils. Bluffton and Glencoe soils are very poorly drained, and Shooker soils are poorly drained; all of these soils are in wet depressions and wet drainageways. Nebish soils are well drained; they are on convex slopes, in positions above those of the Beltrami soil.

Permeability is moderate. The available water capacity is high. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow to medium. The seasonal high water table is at a depth of 2 to 4 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Returning crop residue to the soil and applying manure help improve fertility, reduce crusting, and increase water infiltration and the available water capacity.

The soil is well suited to use as pasture. Proper fertilizing is most effective in increasing production. Proper stocking rates, pasture rotation, and restricted use during wet periods help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides can help control competing vegetation, including weeds.

The soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control competing vegetation.

The soil is suitable for building site development. The main limitation is wetness. The lowest or basement level of a building should be constructed above the seasonal high water table. Tile drains around a foundation help to remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around the foundation with suitable coarse material also helps prevent structural damage. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIe and in woodland suitability group 2o.

129—Cylinder loam. This is a nearly level, somewhat poorly drained soil on outwash plains and stream terraces. It is on broad flats and in shallow swales. The areas vary in shape and range from 5 to 25 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 5 inches thick. The subsoil is about 17 inches thick. The upper part is dark grayish brown loam and dark grayish brown, mottled loam. The lower part is dark brown and grayish brown, mottled loamy coarse sand. The underlying material is dark brown and grayish brown, calcareous gravelly coarse sand to a depth of at least 60 inches. In some areas the soil is more poorly drained, and in others it is better drained.

Included with this soil in mapping and making up 1 to 10 percent of the map unit are small areas of Estherville soils. Estherville soils are well drained and are in higher positions than the Cylinder soil, and they have a loamy mantle that is less than 20 inches thick.

Permeability is moderate in the upper part of the soil and very rapid in the underlying material. The available water capacity is moderate. The content of organic matter is high, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of 2 to 4 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major limitations are the moderate available water capacity and the seasonal high water table in spring at planting time. Returning crop residue to the soil, conservation tillage, and applying manure help improve fertility and tilth and conserve moisture. Crops respond

well to a balanced fertilization program. Irrigation can minimize the effects of drought.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is suitable for building site development. Wetness is the main limitation. Buildings should be constructed so that the lower or basement level is above the seasonal high water table. Tile drains around the foundation help to remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around the foundation with suitable coarse material also helps prevent structural damage. Constructing roads on well compacted, coarse textured fill material helps prevent damage by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIs.

133B—Dalbo loam, 2 to 8 percent slopes. This is a gently sloping, moderately well drained soil on plane to slightly convex parts of outwash plains. The individual areas vary in shape and range from 5 to 20 acres in size.

Typically, the surface layer is black loam about 3 inches thick. The subsurface layer is very dark grayish brown very fine sandy loam and is also about 3 inches thick. The subsoil is about 24 inches thick. The upper part is dark brown very fine sandy loam, and the lower part is dark yellowish brown loam and clay loam. The underlying material is grayish brown, mottled clay to a depth of at least 60 inches.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Hubbard soils, which are well drained. Hubbard soils are on convex rises and are coarser textured than the Dalbo soil.

Permeability is slow and moderately slow. The available water capacity is high. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow to medium. The seasonal high water table is at a depth of 3 to 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major problem is the hazard of erosion. Conservation tillage, contour farming, returning crop residue, applying manure, and crop rotation are effective in controlling erosion, maintaining tilth and fertility, and conserving moisture.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control competing vegetation.

The soil is suitable for building site development. However, the potential for shrinking and swelling, according to changes in the moisture content, is high. Foundations and footings of buildings, consequently, should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around a foundation with suitable coarse material also helps prevent damage to the structure. Constructing roads on well compacted, coarse textured base material helps prevent damage to the roads resulting from frost action, low soil strength, and the shrinking and swelling of the soil. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. Also, the slow and moderately slow permeability prevents the soil from readily absorbing effluent. In places a mound system can be installed: the absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIe and in woodland suitability group 1o.

142—Nokay fine sandy loam. This is a nearly level, somewhat poorly drained soil on the slightly concave base of slopes in drumlin fields and on ground moraines. The areas vary in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black fine sandy loam about 4 inches thick. The subsurface layer is dark grayish brown, mottled sandy loam about 8 inches thick. The subsoil is dark grayish brown, mottled loam and dark brown sandy loam and is about 28 inches thick. The underlying material is dark brown, mottled sandy loam to a depth of at least 60 inches. In some small areas there are free carbonates in the underlying material. In areas adjacent to outwash soils, the surface texture is coarser than is typical. Also, in some areas the soil is better drained.

Included with this soil in mapping and making up 2 to 15 percent of some mapped areas are small areas of Flak and Prebish soils. Flak soils are well drained; they

are more sloping than the Nokay soil and are in slightly higher positions on knolls. Prebish soils are poorly drained and very poorly drained; they are in depressions and drainageways.

Permeability is moderately slow. The available water capacity is moderate. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

In most areas this soil is used for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major limitations are wetness and stones. The seasonal high water table delays fieldwork early in spring. It can be lowered by installing an adequate drainage system. Stones interfere with cultivation, and rock removal commonly is needed. Returning crop residue and applying manure to the soil help maintain tilth and fertility. Liming increases the effectiveness of fertilizers and improves grass and legume stands.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, pasture rotation, and deferment of grazing when the soil is too wet help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides can control competing vegetation, including weeds.

The soil is well suited to use as woodland. The main concerns are plant competition and seedling mortality caused by wetness. Site preparation and cutting, spraying, girdling, or prescribed burning control plant competition. Seedling mortality can be reduced by planting only those species that tolerate wetness.

The soil is poorly suited to building site development because of wetness. Buildings constructed on this soil should be built without a basement. Land shaping is needed to drain surface water away from the building foundation. Tile drains around the foundation help to remove excess subsurface water. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed; the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw and in woodland suitability group 2o.

144B—Flak sandy loam, 4 to 8 percent slopes. This is a gently sloping, well drained soil on convex crests and side slopes of knolls on ground moraines and of drumlins. The areas vary in shape and range from 4 to 40 acres in size.

Typically, the surface layer is very dark brown sandy loam about 4 inches thick. The subsurface layer is brown sandy loam about 12 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown sandy loam, and the lower part is firm, dark brown sandy loam. The underlying material is firm, dark brown sandy loam to a depth of at least 60 inches. In some places near outwash areas there is a sandy mantle as much as 20 inches thick above the till. In some small areas the underlying material includes calcareous till that is yellowish in hue. In some areas there is an accumulation of clay in the subsoil. In some areas the soil is not so well drained, or it is better drained than is typical.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Chetek and Prebish soils. The somewhat excessively drained Chetek soils formed in sand deposits in the till. The very poorly drained Prebish soils are in wet depressions and drainageways.

Permeability is moderately slow. The available water capacity is moderate. The content of organic matter is low, and natural fertility is medium. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

In most areas this soil is used for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major concerns in management are erosion and stone removal. Conservation tillage, contour farming, returning crop residue, applying manure, and crop rotation are effective in controlling erosion, maintaining tilth and fertility, and conserving moisture. Grassed waterways, placed where runoff concentrates, help prevent excessive soil loss and gullying. In some places there are stones that interfere with cultivation, and rock removal commonly is needed (fig. 8). Liming increases the effectiveness of fertilizers and improves legume stands.

The soil is well suited to use as pasture, and this use is effective in controlling erosion. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control competing plants.

The soil is well suited to building site development. Using well compacted, coarse textured fill material for roadbeds helps prevent damage to the roads by frost action. The moderately slow permeability prevents the soil from readily absorbing the effluent in septic tank

Figure 8.—This field, in an area of Flak sandy loam, 4 to 8 percent slopes, is being cleared of stones and boulders. Some stones have been placed in a row, ready to be buried in a trench. Flak soils commonly have large rocks and boulders that can interfere with farming operations.

absorption fields. A larger than average absorption field helps overcome this limitation.

This soil is in capability subclass IIe and in woodland suitability group 2d.

144C—Flak sandy loam, 8 to 15 percent slopes. This is a sloping, well drained soil on convex crests and side slopes of drumlins and ground moraines. The areas vary in shape and range from 5 to 20 acres in size.

Typically, the surface layer is black sandy loam about 3 inches thick. The subsurface layer is brown sandy loam about 12 inches thick. The subsoil is about 27 inches thick. The upper part is dark brown sandy loam, and the lower part is firm, dark brown sandy loam. The underlying material is firm, dark brown sandy loam to a depth of at least 60 inches. In some places near outwash areas there is a sandy mantle as much as 20 inches thick above the till. In some small areas the underlying material includes calcareous till that is yellowish in hue. In some small areas there is an accumulation of clay in the subsoil. In some areas the soil is not so well drained, or it is better drained than is typical.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Chetek and Prebish soils. The somewhat excessively

drained Chetek soils formed in sand deposits in the till. The very poorly drained Prebish soils are in wet depressions and drainageways.

Permeability is moderately slow. The available water capacity is moderate. The content of organic matter is low, and natural fertility is medium. Surface runoff is medium to rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. The major concerns are erosion and stone removal. Minimum tillage, contour farming, returning crop residue, applying manure, and using grasses and legumes in the crop rotation are effective in controlling erosion, maintaining tilth and fertility, and conserving moisture. Grassed waterways, placed where runoff concentrates, help prevent excessive soil loss and gullying. Stones in this soil interfere with cultivation; their removal commonly is needed. Liming increases the effectiveness of fertilizers and improves grass and legume stands.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control competing plants.

The soil is well suited to building site development. Erosion, however, is a hazard on construction sites. Using well compacted, coarse textured fill material for roadbeds helps protect the roads from damage by frost action. The soil is poorly suited to septic tank absorption fields because of its slope and because its moderately slow permeability impedes absorption of the effluent. Some land shaping and a larger than average absorption field help overcome these limitations.

This soil is in capability subclass IIIe and in woodland suitability group 2d.

144E—Flak sandy loam, 15 to 25 percent slopes. This is a moderately steep to steep, well drained soil on summits and side slopes of drumlins and ground moraines. The areas vary in shape and range from 5 to 25 acres in size.

Typically, the surface layer is very dark brown sandy loam about 3 inches thick. The subsurface layer is brown sandy loam about 11 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown sandy loam, and the lower part is firm, dark brown sandy loam. The underlying material is firm, dark brown sandy loam to a depth of at least 60 inches. In some places near outwash areas there is a sandy mantle as much as 20 inches thick above the till. In some small areas the underlying material includes calcareous till that is yellowish in hue. In other small areas there is an accumulation of clay in the subsoil. In some areas the soil is not so well drained, or it is better drained than is typical.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Chetek and Prebish soils. The somewhat excessively drained Chetek soils formed in sand deposits in the till. The very poorly drained Prebish soils are in wet depressions and drainageways.

Permeability is moderately slow. The available water capacity is moderate. The content of organic matter is low, and natural fertility is medium. Surface runoff is rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture and woodland. Maintaining a permanent vegetative cover for the production of forage or wood products provides the protection this soil requires.

The soil is fairly well suited to use as pasture. Proper fertilizing, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce good yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Water erosion is severe unless the area is kept vegetated; site preparation should be limited to the area within 2 feet of the plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. The steep slopes limit the use of equipment. Other concerns are plant competition, droughtiness on slopes facing south or west, and the hazard of erosion. Cutting, spraying, girdling, and prescribed burning help control competing vegetation. Mulching, timely planting, planting drought-tolerant species, and planting on north- and east-facing slopes reduce seedling mortality caused by droughtiness. Soil erosion can be controlled by maintaining an adequate ground cover.

Slope is a limitation to the use of this soil for building sites. Extensive land shaping generally is needed, and erosion is a severe hazard. Buildings should be designed to conform to the natural slope. Extensive cuts and fills commonly are needed in road construction. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil is poorly suited to use as septic tank absorption fields because of its slope and because it does not readily absorb effluent.

This soil is in capability subclass VIe and in woodland suitability group 2d.

155B—Chetek sandy loam, 1 to 6 percent slopes. This is a nearly level to gently sloping, somewhat

excessively drained soil on knolls and concave side slopes on outwash plains and ground moraines. The areas vary in shape and range from 5 to 20 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 6 inches thick. The subsurface layer is brown sandy loam about 7 inches thick. The subsoil is dark reddish brown sandy loam about 10 inches thick. The underlying material is reddish brown gravelly loamy coarse sand and gravelly coarse sand to a depth of at least 60 inches. In some places, coarse fragments make up less than 15 percent of the underlying material. Also, in places the sandy loam mantle is more than 24 inches thick.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Mahtomedi soils. The excessively drained Mahtomedi soils are in the same positions on the landscape as the Chetek soil, but they are sandy throughout.

Permeability is moderately rapid in the loamy mantle and rapid in the underlying material. The content of organic matter and the level of natural fertility are low. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

In most areas this soil is used as pasture or woodland. If the soil is pastured, proper stocking rates, rotation grazing, and weed control help to maintain an adequate plant cover. Supplemental pasture usually is needed in summer. Permanent pasture of warm-season grasses produces forage during the hot summer months when bluegrass is dormant.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetative cover should be left to reduce soil blowing while young trees are becoming established. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is fairly well suited to use as woodland. The main concern in management is seedling mortality caused by droughtiness and soil blowing. Droughtiness can be partly overcome by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining a close-growing plant cover on adjacent fields. Replacement of some seedlings may be necessary.

The soil is fairly well suited to corn, small grains, and forage grasses and legumes. The main concerns are the low available water capacity and the hazard of erosion. Conservation tillage, a crop rotation that includes forage crops, and the return of crop residue to the soil help to reduce erosion and to improve the available water capacity and fertility. Liming increases the effectiveness of fertilizers and improves legume stands. Irrigation can minimize the effects of drought.

This soil is suitable for building site development; however, it is subject to severe erosion. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be needed in some areas. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should have at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be used; the septic tank absorption field is installed in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIe and in woodland suitability group 3s.

156A—Fairhaven loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on broad outwash plains and valley trains. The areas vary in shape and range from 5 to 150 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layers are very dark brown and dark brown loam about 10 inches thick. The subsoil is about 17 inches thick. The upper part is dark yellowish brown loam. The lower part is dark yellowish brown loamy coarse sand. The underlying material is light yellowish brown, calcareous coarse sand to a depth of at least 60 inches. In some areas the loamy mantle is thinner than is typical. In some small areas in swales the dark surface and subsurface layers are more than 20 inches thick. Also, in some areas the soil is not so well drained.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Biscay and Ridgeport soils. Biscay soils are poorly drained; they are in wet depressions and in drainageways. Ridgeport soils are somewhat excessively drained; they have an accumulation of clay in the subsoil.

Permeability is moderate in the loamy mantle and rapid in the sandy underlying material. The available water capacity is moderate. The content of organic matter is high, and natural fertility is medium. Surface runoff is slow. The depth to the seasonal high water table is more than 6 feet.

In most areas this soil is used for crops. It is well suited to corn, small grains, and forage grasses and legumes. The soil is somewhat droughty because its available water capacity is moderate, but irrigation can minimize the effects of drought. Conservation tillage, crop residue returned to the soil, and manure spread on the soil help increase the water-holding capacity, reduce evaporation, and maintain tilth and fertility.

This soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help to maintain the desirable pasture plants and to produce high yields of forage.

This soil is well suited to windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is well suited to building site development. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should have at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous, sandy layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIs.

156B—Fairhaven loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on convex ridges, on knolls, and on uneven, concave side slopes on broad outwash plains and valley trains. The areas vary in shape and range from 3 to about 20 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 23 inches thick. The upper part is dark brown and dark yellowish brown loam. The lower part is yellowish brown loamy coarse sand. The underlying material is light yellowish brown, calcareous coarse sand to a depth of at least 60 inches. In some areas the loamy mantle is thinner than is typical. In some small areas in swales the dark surface and subsurface layers are more than 20 inches thick. In some small areas the slope is less than 2 percent or more than 6 percent.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Biscay and Ridgeport soils. Biscay soils are poorly drained; they are in wet depressions and in drainageways. Ridgeport soils are somewhat excessively drained; they have an accumulation of clay in the subsoil; and they are on convex knolls.

Permeability is moderate in the loamy mantle and rapid in the sandy underlying material. The available water capacity is moderate. The content of organic matter is high, and natural fertility is medium. Surface runoff is medium. The depth to the seasonal high water table is more than 6 feet.

In most areas this soil is used for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major concern in management is the hazard of erosion. Conservation tillage, contour farming, the return of crop residue to the soil, and applications of manure help control erosion, increase the water-holding capacity, reduce evaporation, and help maintain tilth and fertility. The soil is somewhat droughty because its available water capacity is moderate, but irrigation can minimize the effects of drought.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help to maintain the proportion of desirable plants and to produce high yields of forage.

The soil is well suited to windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Cultivation or herbicides help to control competing vegetation.

The soil is well suited to building site development. Constructing roads on well compacted, coarse textured fill material helps protect the roads from damage caused by frost action. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should have at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous, sandy layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIe.

159B—Anoka loamy sand, 2 to 8 percent slopes. This is a gently sloping, well drained soil on crests and side slopes on outwash plains. The areas vary in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 9 inches thick. The subsurface layer is yellowish brown loamy sand about 5 inches thick. The upper part of the subsoil is about 22 inches thick. It is dark yellowish brown fine sandy loam and yellowish brown very fine sandy loam and loamy sand. The next layers are 16 inches thick; they are yellowish brown sand and light yellowish brown fine sand. The lower part of the subsoil is brown fine sandy loam 3 inches thick. The underlying material is yellowish brown fine sand to a depth of at least 60 inches. This soil has repeating bands of finer textured material. In some areas there are sandy soils that do not have distinct bands in the subsoil.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of Dorset and Nymore soils. The well drained Dorset soils have more clay in the subsoil than the Anoka soil. The excessively drained Nymore soils are sandy throughout. The Dorset and Nymore soils and the Anoka soil are in similar positions on the landscape.

Permeability is moderately rapid. The available water capacity is low. The content of organic matter and the

level of natural fertility are low. Surface runoff is slow to medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. Erosion and drought can greatly reduce crop growth. If shallow-rooting crops are grown on this soil, varieties that mature early should be selected. Irrigation can help to minimize the hazard of drought. Management practices are needed that help reduce erosion, minimize the effects of drought, and maintain fertility. Returning crop residue to the soil and applying manure help improve fertility and tilth and conserve moisture. Crops respond well to a balanced fertilization program. Liming increases yields of grass and legume stands.

The soil is fairly well suited to use as pasture. Pasture rotation, proper fertilization, liming, weed control, and proper stocking rates help to maintain a desirable plant community. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

The soil is fairly well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil has fair suitability for use as woodland. The main limitation is seedling mortality caused by droughtiness and by soil blowing. Droughtiness can be partly overcome by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining vegetative cover on adjacent fields. Replacement of some seedlings may be necessary.

The soil is well suited to building site development. Constructing roads on well compacted, coarse textured base material helps prevent damage to the roads by frost action. The soil is suitable for use as septic tank absorption fields.

This soil is in capability subclass IIIe and in woodland suitability group 3s.

163B—Brainerd fine sandy loam, 1 to 4 percent slopes. This is a nearly level to gently sloping, moderately well drained soil on ground moraines and drumlins. It is on plane to slightly convex flats and low-lying side slopes. The areas vary in shape and range from 5 to 70 acres in size.

Typically, the surface layer is very dark brown fine sandy loam about 6 inches thick. The subsurface layer is dark grayish brown and dark brown, mottled fine sandy loam about 9 inches thick. The subsoil is dark brown and brown, mottled sandy loam and fine sandy loam and is about 40 inches thick. The underlying material is dark brown, mottled sandy loam to a depth of at least 60 inches. In some places there is an accumulation of clay in the subsoil, or the underlying material is calcareous. In some areas next to outwash plains, the surface and subsurface layers are coarse sandy loam or loamy sand. Also, in some areas the soil is not so well drained, or it is better drained.

Included with this soil in mapping and making up 2 to 10 percent of the map unit are small areas of Prebish soils. Prebish soils are poorly drained and very poorly drained; they are on flats and in drainageways, depressions, and wet swales.

Permeability is moderately slow. The available water capacity is moderate. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow to medium. There is a perched high water table at a depth of 1.5 to 2.5 feet for brief periods.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. The hazard of erosion is the major concern in management. Conservation tillage, applying manure, and returning crop residue to the soil help to control erosion, improve fertility and tilth, and conserve moisture. A crop rotation is effective in controlling erosion and conserving moisture. In some areas stones are a hindrance to the use of equipment and should be removed. Liming increases the effectiveness of fertilizers and improves legume stands.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major concern. Site preparation, cultivation, and cutting, spraying, girdling, or prescribed burning can control competing vegetation.

The soil is suited to building site development. Wetness, however, is a major concern. Buildings should have the lower or basement level constructed above the seasonal high water table. Tile drains around the foundation help to remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to overcome the wetness limitation and to prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal water table at least 3 feet below the seepage trench. In places a mound system can be used: the septic tank absorption field is installed in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIe and in woodland suitability group 2d.

179B—Langola loamy sand, 1 to 4 percent slopes. This is a nearly level to gently sloping, well drained and moderately well drained soil on crests and side slopes of ground moraines within outwash plains. The slopes are plane to convex. The individual areas vary in shape and range from 5 to 80 acres in size.

Typically, the surface layer is black loamy sand about 10 inches thick. The subsurface layer is dark brown loamy sand about 9 inches thick. The subsoil is about 30 inches thick. The upper part is dark yellowish brown and yellowish brown fine sand, and the lower part is dark brown, mottled sandy loam. The underlying material is dark brown sandy loam to a depth of at least 60 inches. In some places, thin discontinuous strata or pockets of loamy sand are in the underlying material.

Included with this soil in mapping and making up 2 to 10 percent of the map unit are small areas of Brainerd, Hubbard, and Watab soils. Brainerd soils are moderately well drained and are on gentle slopes where there is no sandy mantle. Hubbard soils are excessively drained and are on concave slopes and toe slopes. Watab soils are somewhat poorly drained and are in narrow swales and small depressions.

Permeability is rapid in the upper part of the soil and moderately slow in the lower part. The available water capacity is moderate. The content of organic matter is medium, and natural fertility is low. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. It is droughty in dry spells, and if cultivated it is subject to wind erosion. A cropping system that conserves moisture and maintains or increases the content of organic matter is needed. Field shelterbelts and wind stripcropping help reduce wind erosion. A balanced fertilizer program, liming, applying manure, and returning crop residue to the soil improve fertility and tilth. Irrigation can minimize the effects of drought.

The soil is fairly well suited to use as pasture. Adequate liming, fertilizing, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of nutritious forage. Permanent pasture of warm-season grasses provides good forage during the hot summer months when bluegrass is dormant. Deferment of grazing early in spring and late in fall allows the pasture plants to regain vigor and reduces losses from winterkill.

The soil has fair suitability for windbreaks and environmental plantings. Only those trees and shrubs that withstand droughty conditions should be selected for planting. Some vegetative cover should be left to reduce soil blowing while young trees are becoming established. Seedling mortality is moderate because droughtiness can cause moisture stress in the seedlings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil has fair suitability for use as woodland. The main limitation is seedling mortality caused by droughtiness and by soil blowing. Droughtiness can be partly offset by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining a vegetative cover on adjacent fields. Replacement of some seedlings may be necessary.

The soil is well suited to building site development and to local roads. It is poorly suited to septic tank absorption fields because the lower part of the soil does not readily absorb effluent. A larger than average absorption field helps to lessen the severity of this limitation.

This soil is in capability subclass IIIs and in woodland suitability group 3s.

180A—Gonvick loam, 1 to 2 percent slopes. This is a nearly level, moderately well drained and somewhat poorly drained soil on ground moraines. It is on flats and slight convex rises. The areas vary in shape and range from 5 to about 40 acres in size.

Typically, the surface layer is black loam about 5 inches thick. The subsurface layer is black loam about 7 inches thick. The subsoil is about 18 inches thick. The upper part is dark brown, mottled clay loam, and the lower part is dark grayish brown and grayish brown, mottled clay loam. The underlying material is grayish brown and light olive brown, mottled, calcareous loam to a depth of at least 60 inches. In some places, the subsoil is less developed and has weaker structure. Also, in some areas the dark surface soil is less than 8 inches thick.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Cordova, Glencoe, and Waukon soils. Cordova soils are poorly drained and are in wet swales and drainageways. Glencoe soils are very poorly drained and are in depressions. Waukon soils are well drained and are on higher rises and knobs.

Permeability is moderate. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 2.5 to 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Conservation tillage, applying manure, and returning crop residue to the soil help to improve fertility and tilth and to conserve moisture.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help maintain desirable grasses for high forage production.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings.

Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning can control competing vegetation.

This soil is suitable for building site development. The major limitation is wetness. The lowest or basement level of a building should be constructed above the seasonal high water table. Tile drains around the foundation help to remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around the foundation with suitable coarse material also helps prevent structural damage. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability class I and in woodland suitability group 2o.

180B—Gonvick loam, 2 to 4 percent slopes. This is a gently undulating, moderately well drained and somewhat poorly drained soil on ground moraines. It is on a series of convex ridges and in the intervening swales. The areas vary in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black loam about 5 inches thick. The subsurface layer is very dark gray loam about 7 inches thick. The subsoil is about 18 inches thick. The upper part is brown and dark brown clay loam; the middle part is dark grayish brown, mottled clay loam; and the lower part is olive gray, mottled clay loam. The underlying material is olive gray and light olive brown, mottled, calcareous loam to a depth of at least 60 inches. In some places, the subsoil is less developed. Also, in some areas the dark surface soil is less than 8 inches thick.

Included with this soil in mapping and making up 10 to 15 percent of most mapped areas are small areas of Hamel, Waukon, and Cordova soils. Hamel and Cordova soils are poorly drained and are in drainageways and wet swales. Waukon soils are well drained and are on the highest convex rises.

Permeability is moderate. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 2.5 to 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling erosion and maintaining fertility are the main concerns in management. Conservation tillage, the return of crop residue to the soil, and proper crop rotation are effective in controlling erosion. In some areas, grassed waterways are needed to stop gullying. Adding lime helps to establish alfalfa and allows crops to respond better to fertilizers.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help maintain desirable grasses for high forage production.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning can control competing vegetation.

The soil is suitable for building site development. Wetness is a concern. The lowest or basement level of a building should be constructed above the seasonal high water table. Tile drains around the foundation help to remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around the foundation with suitable coarse material also helps prevent structural damage. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIe and in woodland suitability group 2o.

181—Litchfield loamy sand. This is a nearly level, moderately well drained and somewhat poorly drained soil on outwash plains. It is on smooth, broad flats and low, convex rises. The areas vary in shape and range from 5 to 35 acres in size.

Typically, the surface layer is very dark brown loamy sand about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown loamy sand about 12 inches thick. The subsoil is about 24 inches thick. The upper part is dark brown, mottled loamy sand; the middle part is yellowish brown, mottled fine sand; and the lower part is grayish brown, mottled fine sandy loam. The underlying material is light brownish gray,

mottled sand to a depth of at least 60 inches. In some places there is no banding in the subsoil.

Included with this soil in mapping and making up 3 to 10 percent of the map unit are small areas of Dassel and Darfur soils. Dassel soils are poorly drained and very poorly drained and are in small, deep depressions. Darfur soils are poorly drained and are in concave swales and drainageways.

Permeability is moderately rapid. The available water capacity is moderate. Natural fertility is low, and the content of organic matter is moderate. Surface runoff is slow. The seasonal high water table is at a depth of 2.5 to 5 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. Management concerns are the moderate available water capacity, wind erosion, and maintaining fertility and tilth. Returning crop residue to the soil and applying manure improve fertility and tilth, conserve moisture, and reduce wind erosion. Liming improves the effectiveness of fertilizers. Irrigation can minimize the effects of drought.

The soil is well suited to use as pasture. Proper stocking, fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce good yields of forage. Permanent pasture of warm-season grasses provides good forage during the hot summer months when bluegrass is dormant.

The soil is fairly well suited to trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to building site development. Wetness is a concern. The lowest or basement level of a building should be constructed above the seasonal high water table. Tile drains around the foundation help to remove excess subsurface water. Land shaping should be designed to drain surface water away from buildings. Constructing roads on well compacted, coarse textured fill material helps to prevent damage to the roads by frost action. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIs.

183—Dassel sandy loam. This is a level, poorly drained and very poorly drained soil in wet drainageways and depressions on outwash plains and valley trains. The areas vary in shape and range in size from 5 to about 40 acres.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is black and very dark grayish brown sandy loam and is about 3 inches thick. The subsoil is about 17 inches thick. It is olive gray and grayish brown, mottled sandy loam, coarse sandy loam, and fine sandy loam. The underlying material is light olive brown and olive gray, mottled loamy sand and gravelly coarse sand to a depth of at least 60 inches. There are some bands of fine textured and coarse textured material in the subsoil and underlying material.

Included with this soil in mapping and making up 2 to 10 percent of the map unit are small areas of Estherville and Litchfield soils. Estherville soils are well drained; they are in higher positions than the Dassel soil, and they have no banding. Litchfield soils are moderately well drained. They are on higher lying flats and low, convex rises.

Permeability is moderately rapid in the upper part of the soil and rapid in the underlying material. The available water capacity is moderate. The content of organic matter is high, and natural fertility is medium. Surface runoff is very slow. The seasonal high water table is at a depth of 0.5 foot to 3 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. The major concerns are wetness and maintaining the level of fertility. Selecting varieties that tolerate wetness is important, because some may drown out or be short-lived. Adequate drainage and a cropping system that maintains or improves the soil structure and tilth are necessary for sustained good yields.

The soil is fairly well suited to use as pasture. The major management concern is the seasonal high water table. Deferring grazing when the soil is wet helps prevent soil compaction and impaired tilth. Adequate drainage can lower the water table. Proper fertilization and pasture rotation help maintain a desirable plant community.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate excess moisture conditions should be selected for planting. Seedling mortality is severe because of wetness. Cultivation or herbicides can help control competing vegetation, including weeds.

The soil is well suited to use as habitat for wetland wildlife. The areas can be improved for this use by constructing impoundments, for example, shallow excavated ponds for migratory waterfowl and elongated ditches for furbearers.

The soil is poorly suited to use as building sites because of wetness. Buildings on this soil should be constructed without a basement, and the land should be graded to drain surface water away from the building foundation. Tile drains around the foundation help to remove excess subsurface water. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to overcome the wetness limitation and to prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the highest level of the seasonal water table 3 feet below the seepage trench. In

places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIw.

200B—Holdingford sandy loam, 4 to 8 percent slopes. This is a gently sloping, well drained soil on slightly convex crests and side slopes on ground moraines and drumlin fields. The areas vary in shape and range from 4 to 40 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is dark grayish brown sandy loam about 4 inches thick. The subsoil is about 25 inches thick. The upper part is dark yellowish brown sandy loam, and the lower part is brown sandy loam. The underlying material is yellowish brown sandy loam to a depth of at least 60 inches. In some areas adjacent to outwash deposits, the soil has a sandy mantle as much as 15 inches thick. In some areas the subsoil does not have calcareous glacial till that is yellowish brown in hue. In some areas the soil is moderately well drained.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Prebish soils, which are very poorly drained. Prebish soils are on small flats and in depressions.

Permeability and the available water capacity are moderate. The content of organic matter is moderate. Natural fertility is medium. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major concerns in management are erosion and stone removal. Conservation tillage, contour farming, terracing, returning crop residue, applying manure, and a suitable crop rotation help to improve fertility and tilth, to conserve moisture, and to reduce erosion. Liming increases the effectiveness of fertilizers and improves legume stands.

The soil is well suited to use as pasture. This use is effective in controlling erosion. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of quality forage. Deferring grazing early in spring and late in fall prevents damage to the pasture by browsing or trampling and allows the pasture plants to regain vigor.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control competing vegetation.

The soil is well suited to building site development. Roads should be placed on well compacted, coarse textured fill material to help prevent damage by frost action. Because its permeability is moderate, this soil does not readily absorb the effluent from a septic tank absorption field. A larger than average drain field helps to overcome this limitation.

This soil is in capability subclass IIe and in woodland suitability group 2o.

200C—Holdingford sandy loam, 8 to 15 percent slopes. This is a sloping, well drained soil on crests and convex side slopes on drumlin fields and ground moraines. The areas vary in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The subsurface layer is dark grayish brown sandy loam about 4 inches thick. The subsoil is about 22 inches thick. The upper part is dark yellowish brown sandy loam, and the lower part is dark brown sandy loam. The underlying material is yellowish brown sandy loam to a depth of at least 60 inches. In some small areas the subsoil does not contain calcareous glacial till that is yellowish brown in hue. In some areas the soil is moderately well drained.

Included with this soil in mapping and making up 2 to 10 percent of some mapped areas are small areas of Chetek and Prebish soils. Chetek soils are somewhat excessively drained and are on sandy knolls in areas of glacial till. Prebish soils are very poorly drained and are in wet depressions and drainageways.

Permeability and the available water capacity are moderate. The content of organic matter is moderate. Natural fertility is medium. Surface runoff is medium to rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as cropland and pasture. It is fairly well suited to corn, small grains, and forage grasses and legumes. The major management concerns are erosion and stone removal. Conservation tillage, contour farming, returning crop residue to the soil, applying manure, and a crop rotation that includes close-growing crops help to improve fertility and tilth, to conserve moisture, and to reduce erosion. Liming increases the efficiency of fertilizers and improves legume stands.

The soil is well suited to use as pasture. This use is effective in controlling erosion. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of excellent forage. Deferring grazing early in spring and late in fall prevents damage by browsing or trampling and allows the pasture plants to regain vigor.

The soil is well suited to a wide variety of trees and shrubs for windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control the competing vegetation.

This soil is suitable for building site development. Erosion is a hazard during construction. Building sites should be designed to conform to the natural slope. Land shaping may be needed in some areas. Roads constructed on this soil should be placed on the contour, where possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. Building roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. Because of its moderate permeability, this soil does not readily absorb the effluent from septic tank absorption fields. Also, slope is a limitation. Installing a larger than average drain field and placing the distribution lines across the slope help overcome these limitations.

This soil is in capability subclass IIIe and in woodland suitability group 2o.

204B—Cushing sandy loam, 2 to 8 percent slopes. This is a gently undulating, well drained soil. It is on convex and concave parts of knolls and side slopes on ground and end moraines. The areas vary in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark brown sandy loam about 5 inches thick. The subsurface layer is dark brown sandy loam about 10 inches thick. The subsoil is dark brown and brown loam and sandy clay loam about 32 inches thick. The underlying material is dark brown sandy loam to a depth of 60 inches or more. In some places the subsoil and underlying material are coarser textured than is typical or have a yellower hue. Also, in places the surface layer is thicker. In some areas the soil is moderately well drained.

Included with this soil in mapping and making up 5 to 15 percent of some mapped areas are small areas of DeMontreville, Nokay, Jewett, and Prebish soils. The well drained DeMontreville soils have a sandy mantle 20 to 40 inches thick over brown sandy loam glacial till. They and the Cushing soil are in similar positions on the landscape. The somewhat poorly drained Nokay soils and the very poorly drained Prebish soils are closely intermingled in depressions and drainageways. The well drained Jewett soils have a silty mantle 15 to 30 inches thick over brown sandy loam glacial till. They and the Cushing soil are in similar positions on the landscape.

Permeability is moderately slow, and the available water capacity is moderate. The content of organic matter is moderately low, and natural fertility is medium. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major management concerns are stones in the soil and water erosion. Conservation tillage, returning crop residue to the soil, applying manure, and including grasses and legumes in a crop rotation help control erosion, maintain tilth, and conserve moisture. Grassed waterways help prevent excessive soil loss. Liming increases the effectiveness of fertilizers and improves legume stands.

This soil is well suited to use as pasture. This use is effective in controlling erosion. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of excellent forage. Deferring grazing early in spring and late in fall prevents damage to the pasture by browsing or trampling and allows the pasture plants to regain vigor for future growth.

This soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control the competing vegetation.

This soil is well suited to building site development. If roads are constructed on this soil, they should be placed on well compacted, coarse textured base material to help prevent damage to the roads by frost action. Because of its moderately slow permeability, this soil does not readily absorb effluent in a septic tank absorption field. A larger than average field can help overcome this limitation.

This soil is in capability subclass IIe and in woodland suitability group 2o.

204C—Cushing sandy loam, 8 to 15 percent slopes. This is a rolling, well drained soil on knolls and concave side slopes of ground and end moraines. The areas vary in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 5 inches thick. The subsurface layer is dark brown and yellowish brown sandy loam about 7 inches thick. The subsoil is about 19 inches thick. The upper part is dark yellowish brown sandy loam, and the lower part is dark brown sandy clay loam. The underlying material is dark brown sandy loam to a depth of at least 60 inches. In some places the subsoil and underlying material are coarser textured than is typical or have a yellower hue. In some areas the soil is moderately well drained.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of DeMontreville, Nokay, Prebish, and Jewett soils. The well drained DeMontreville soils have a sandy mantle 20 to 40 inches thick over brown sandy loam glacial till. They and the Cushing soil are in similar positions on the landscape. The somewhat poorly drained Nokay soils and the very poorly drained Prebish soils are closely intermingled in depressions and drainageways. The well drained Jewett soils have a silty mantle 15 to 30 inches

thick over brown sandy loam glacial till. They and the Cushing soil are in similar positions on the landscape.

Permeability is moderately slow, and the available water capacity is moderate. The content of organic matter is moderately low, and natural fertility is medium. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. The major management concerns are stones in the soil and water erosion. Conservation tillage, returning crop residue to the soil, applying manure, and including grasses and legumes in a crop rotation help control erosion, maintain tilth, and conserve moisture. Grassed waterways help prevent excessive soil loss. Applications of lime increase the effectiveness of fertilizers and improve legume stands.

This soil is well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

This soil is well suited to a wide variety of trees and shrubs for windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control the competing vegetation.

This soil is suitable for building site development. Buildings should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour, if possible, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. Using well compacted, coarse textured base material helps prevent damage to roads by frost action. Because of its moderately slow permeability, this soil does not readily absorb effluent in a septic tank absorption field. A larger than average absorption field can help overcome this limitation.

This soil is in capability subclass IIIe and in woodland suitability group 2o.

204E—Cushing sandy loam, 15 to 25 percent slopes. This is a moderately steep to steep, well drained soil on concave to convex hillsides on ground and end moraines. The areas vary in shape and range from 3 to 30 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 4 inches thick. The subsurface layer is dark brown sandy loam about 6 inches thick. The subsoil is dark brown and brown sandy clay loam about 17 inches thick. The underlying material is dark brown sandy loam to a depth of 60 inches. In some places the subsoil and the underlying material are coarser textured or have a yellower hue than is typical. In some areas the soil is moderately well drained.

Included with this soil in mapping and making up 5 to 15 percent of some mapped areas are small areas of DeMontreville, Nokay, and Prebish soils. The well drained DeMontreville soils have a sandy mantle 20 to 40 inches thick over sandy loam glacial till. They and the Cushing soil are in similar positions on the landscape. The somewhat poorly drained Nokay soils and the very poorly drained Prebish soils are closely intermingled in depressions and drainageways.

Permeability is moderately slow. The available water capacity is moderate. The content of organic matter is moderately low, and natural fertility is medium. Surface runoff is rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture. It is fairly well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is not suited to row crops and small grains because of the steep slopes and the hazard of erosion. A close-growing plant cover is needed to control erosion and runoff.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Water erosion is severe unless the area is kept vegetated; site preparation should be limited to the area within 2 feet of the plantings. Cultivation or herbicides help control competing vegetation, including weeds.

The soil is well suited to use as woodland. However, the moderately steep and steep slopes limit the use of equipment. Other concerns are plant competition, droughtiness on slopes that face south or west, and the hazard of erosion. Cutting, spraying, girdling, and prescribed burning can control competing vegetation. Mulching, timely planting, planting only those species that withstand drought, and planting on north- and east-facing slopes help reduce seedling mortality caused by droughtiness. Erosion can be controlled by maintaining an adequate ground cover.

This soil is suitable for building site development. However, erosion is a severe hazard. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Extensive cuts and fills commonly are needed in road construction. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil is not suited to use as septic tank absorption fields because of the slope and because of its moderately slow permeability.

This soil is in capability subclass VIe and in woodland suitability group 2r.

207B—Nymore loamy sand, 2 to 8 percent slopes. This is an undulating, excessively drained soil on convex

and concave side slopes of knolls. The areas vary in shape and range in size from 5 to 50 acres.

Typically, the surface layer is very dark brown loamy sand about 4 inches thick. The subsurface layer is dark brown loamy sand about 5 inches thick. The subsoil is about 31 inches thick. The upper part is dark brown sand, and the lower part is strong brown and yellowish brown sand. The underlying material is light yellowish brown and pale brown, noncalcareous sand to a depth of at least 60 inches. In places, the subsoil and the underlying material are as much as 10 percent gravel. Also, in some areas there is lime within a depth of 48 inches.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Duelm and Hubbard soils, both of which have a thicker dark surface layer than the Nymore soil. Hubbard soils are excessively drained, and they and the Nymore soil are in similar positions on the landscape. Duelm soils are moderately well drained and somewhat poorly drained and are in lower lying positions.

Permeability is rapid. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

About half of the acreage of this soil is used as cropland. The rest is used as wooded pasture. This soil is poorly suited to most cultivated crops because of droughtiness. Early-maturing crops, such as winter rye, do fairly well in most years. Only deep-rooting grasses and legumes can make any sustained growth on this soil. Management needs are overcoming the hazard of drought and maintaining or improving fertility. Minimum tillage or a winter cover crop helps conserve moisture and protect the soil from blowing. A balanced fertilization program, liming, applying manure, and returning crop residue to the soil help improve fertility. Irrigation can minimize the hazard of drought. However, the response of crops to irrigation is only fair because the available water capacity is low. Center pivot and traveling gun irrigation systems are the types most commonly used.

This soil is fairly well suited to use as pasture. The main management concern is the drought hazard. Overgrazing reduces the protective cover and causes the plant community to deteriorate as the less desirable species increase. Pasture rotation, proper fertilizing, liming, weed control, and proper stocking rates help to maintain a desirable plant community. Permanent pasture of warm-season grasses produces forage during the hot summer months when bluegrass is dormant.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that can withstand droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface while young trees are becoming established to protect them from injury by soil blowing. Controlling weeds and other competing vegetation by cultivation or by herbicides helps reduce plant competition for moisture.

The soil has fair suitability for use as woodland. The main limitation is seedling mortality caused by droughtiness and by soil blowing. Droughtiness can be partly offset by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining vegetative cover on adjacent fields. Replacement of some seedlings may be necessary.

The soil is well suited to building site development and to local roads. It readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IVs and in woodland suitability group 3s.

207C—Nymore loamy sand, 8 to 15 percent slopes. This is a rolling, excessively drained soil on convex and concave side slopes of ridges and knolls. The areas vary in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 6 inches thick. The subsoil is brown sand about 30 inches thick. The underlying material is brown, noncalcareous sand to a depth of at least 60 inches. In places, the subsoil and the underlying material are as much as 10 percent gravel. Also, in some places there is lime within a depth of 48 inches.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Duelm and Hubbard soils, both of which have a thicker dark surface layer than that of the Nymore soil. Hubbard soils are excessively drained, and they and the Nymore soil are in similar positions on the landscape. The Duelm soils are moderately well drained and somewhat poorly drained and are in lower lying positions.

Permeability is rapid. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as woodland. It has fair suitability for trees. Seedling mortality caused by droughtiness and soil blowing is a concern in management. Shallow tillage, mulching, and timely planting help conserve moisture and reduce seedling mortality. Replacement of some seedlings may be necessary. Soil blowing can be controlled by mulching

around the seedlings and maintaining cover on adjacent fields.

This soil is not suited to cultivated crops because of its slope and susceptibility to erosion.

The soil is fairly well suited to use as pasture. The main limitations are the slope and the drought hazard. Overgrazing the pasture reduces the protective cover and causes the plant community to deteriorate as undesirable nuisance species increase. Pasture rotation, proper fertilization, liming, weed control, and proper stocking rates help to maintain a community of desirable pasture plants. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that can withstand droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface while young trees are becoming established to protect them from injury by soil blowing. Controlling weeds and other competing vegetation by cultivation or by herbicides helps reduce plant competition for moisture.

This soil is suitable for building site development. During construction, erosion is a severe hazard. Buildings should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material placed on the surface.

This soil is in capability subclass VIs and in woodland suitability group 3s.

207E—Nymore loamy sand, 15 to 25 percent slopes. This is a hilly to steep, excessively drained soil on convex and concave side slopes. The areas vary in shape and range from 3 to about 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 5 inches thick. The subsoil is brown sand about 24 inches thick. The underlying material is yellowish brown, noncalcareous sand to a depth of at least 60 inches. In places, the subsoil and the underlying material are as much as 10 percent gravel. In some areas lime is within 48 inches of the surface. Also, in some places there is a thick surface layer.

Permeability is rapid, and the available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is rapid. The seasonal high water table is at a depth of more than 6 feet.

In most areas this soil is used as pasture or woodland. Generally, it is not used for crops. It is poorly suited to use as pasture because of its steep slopes and droughtiness. The quality and quantity of forage is poor. Overgrazing reduces the protective cover and increases the hazard of erosion. Weed control and proper stocking rates help maintain an adequate plant cover. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

The soil has fair suitability for windbreaks and environmental plantings. Only those trees and shrubs that withstand droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface while young trees are becoming established to protect them from injury by soil blowing. Water erosion is a severe hazard unless the area is kept vegetated. Site preparation should be limited to the area within 2 feet of the plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil has fair suitability for use as woodland. The steep slopes severely limit the use of equipment. Other concerns are seedling mortality, caused by droughtiness and by soil blowing, and the hazard of water erosion. Only trees that withstand droughty conditions should be selected for planting. Shallow tillage, mulching, and timely planting help to conserve moisture and to reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining a close-growing plant cover on adjacent fields. Water erosion can be controlled by maintaining an adequate ground cover.

Slope is the main limitation of this soil for building sites. Erosion is a severe hazard during construction. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Extensive cuts and fills generally are needed in road construction on this soil. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil is poorly suited to septic tank absorption fields because of its steep slopes and because it does not adequately filter the effluent.

This soil is in capability subclass VIIs and in woodland suitability group 3s.

218—Watab loamy fine sand. This is a nearly level, somewhat poorly drained soil on ground moraines. It is in slightly concave swales and on broad flats at the base of slopes. The areas vary in shape and range from 10 to 100 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 9 inches thick. The subsurface layer is dark

grayish brown and brown, mottled loamy fine sand and fine sand and is about 11 inches thick. The subsoil is brown and dark brown, mottled sandy loam and gravelly fine sandy loam and is about 24 inches thick. The underlying material is dark brown sandy loam to a depth of 60 inches or more. In some depressions, the surface layer is thicker than is typical.

Included with this soil in mapping and making up 5 to 15 percent of some mapped areas are small areas of Langola and Pomroy soils. Langola soils are well drained and moderately well drained; they are on slight rises. Pomroy soils are also well drained and moderately well drained; they are on slightly higher elevations than the Watab soil and on rises.

Permeability is rapid in the sandy upper part of the soil and is moderately slow in the loamy lower part and the underlying material. The available water capacity is moderate. The content of organic matter is moderate, and natural fertility is low. Surface runoff is slow. The seasonal high water table is at a depth of 1.5 to 3 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. The seasonal high water table delays field work early in spring. Adequate artificial drainage is needed. The soil is somewhat droughty during dry spells, and if cultivated, it is subject to wind erosion. A cropping system that helps conserve moisture and increase the content of organic matter is needed. Field shelterbelts and stripcropping help reduce wind erosion. A balanced fertilizer program, applying manure, and returning crop residue to the soil improve fertility and tilth. Liming increases the effectiveness of fertilizers and helps improve legume stands.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, pasture rotation, and deferring grazing when the soil is too wet help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides help control competing vegetation, including weeds.

The soil is fairly well suited to use as woodland. The main concerns in management are plant competition and seedling mortality, which is caused by seasonal droughtiness and wetness. Site preparation, cultivation, and cutting, spraying, girdling, or prescribed burning control competing plants. Mulching, timely planting, and shallow tillage help lower seedling mortality in dry periods. Planting only those species that tolerate wetness helps overcome seedling mortality caused by the seasonal high water table.

This soil is suited to building site development. The main concern is seasonal wetness. Buildings should have the lower or basement level constructed above the seasonal high water table. Tile drains around the foundation help remove excess subsurface water. Land shaping should be designed to drain surface water away from buildings. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to overcome wetness and to prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIw and in woodland suitability group 2d.

233B—Growton sandy loam, 1 to 4 percent slopes. This is a nearly level to gently sloping, moderately well drained soil on plane to slightly convex parts of crests and side slopes on ground moraines and drumlin fields. The areas vary in shape and range from 5 to 60 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsurface layer is dark grayish brown sandy loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown and brown, mottled sandy loam. The underlying material is yellowish brown, mottled, calcareous sandy loam to a depth of at least 60 inches. In some places the subsoil is thicker and free carbonates are at a greater depth than is typical. In some places the surface layer is thicker. In some areas the soil is well drained.

Included with this soil in mapping and making up 2 to 10 percent of most mapped areas are small areas of Prebish soils, which are poorly drained and very poorly drained. Prebish soils are in drainageways, depressions, and wet swales.

Permeability and the available water capacity are moderate. The content of organic matter is moderate. Natural fertility is medium. Surface runoff is slow to medium. The seasonal high water table is at a depth of 3 to 5 feet.

In most areas, this soil is used for crops. It is well suited to corn, small grains, and forage grasses and legumes. The major management concerns are erosion and stones. Conservation tillage, applying manure, and returning crop residue to the soil help to improve fertility and tilth and to conserve moisture. A crop rotation system that includes grasses and legumes is effective in controlling erosion and in maintaining good tilth and the content of organic matter. This soil lends itself well to such practices as contouring and terracing, which help to slow runoff and to control erosion. Liming increases the effectiveness of fertilizers and improves legume stands.

The soil is well suited to use as pasture. Fertilizer and lime, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage. Deferring grazing early in spring and late in fall

prevents damage to the pasture by browsing or trampling and allows the pasture plants to regain vigor.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation and cultivation and cutting, spraying, girdling, or prescribed burning help control competing vegetation.

This soil is well suited to building site development. Wetness is a concern. The lowest or basement level of a building should be constructed above the seasonal high water table. Tile drains around the foundation help remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Constructing roads on well compacted, coarse textured base material helps prevent damage to the roads by frost action. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIe and in woodland suitability group 2o.

236—Vallers loam. This is a nearly level, poorly drained, calcareous soil on ground moraines. It is on the rim of depressions and on broad flats that have scattered depressions. The areas vary in shape and range from 3 to about 40 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray clay loam about 7 inches thick. The subsoil is grayish brown, mottled loam about 15 inches thick. The underlying material is olive gray, mottled loam to a depth of at least 60 inches. In some areas there is no accumulation of lime in the upper 16 inches of the soil. In some areas the soil is very poorly drained.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Flom and Roliss soils. Flom and Roliss soils are in positions on the landscape similar to those of the Vallers soil, but they are noncalcareous.

Permeability is moderately slow. The available water capacity is high. The content of organic matter is high, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 2.5 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling wetness and maintaining fertility are concerns in management. Open ditches and subsurface drainage lines can adequately drain the excess water from this soil where suitable outlets are available. The high calcium content of the soil causes an imbalance of nutrients. Soil tests are needed in planning applications of fertilizer to correct the imbalance.

The soil is well suited to use as pasture. Grazing when the soil is wet and overgrazing, however, cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, fertilization, and restricted use during very wet periods help maintain an adequate cover of desirable grasses for high yields of forage.

The soil has fair suitability for windbreaks and environmental plantings. Only those trees and shrubs that are tolerant of high lime conditions should be planted because the free carbonates in the soil tie up minerals and limit their availability. The species selected should also be tolerant of wetness. Wetness causes moderate seedling mortality and can delay spring planting. Competing vegetation can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as building sites because of the seasonal high water table and the hazard of flooding. If buildings are constructed on this soil, the lower or basement level should be built above the seasonal high water table. Tile drains around the foundation help to remove excess subsurface water. Land shaping should be designed to drain surface water away from buildings. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw.

255—Mayer loam. This is a nearly level, poorly drained, calcareous soil on outwash plains and stream terraces. It is on broad flats, on the rim of depressions, and in shallow, concave swales. The individual areas vary in shape and range from 3 to 20 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layers are very dark gray loam and are about 17 inches thick. The subsoil is dark gray and gray loam and is about 16 inches thick. The underlying material is olive gray sand to a depth of at least 60 inches. In some places, the upper part of the loamy mantle does not have carbonates. In some areas the loamy mantle is less than 20 inches thick. Also, in some places there is an accumulation of lime in the surface layer.

Included with this soil in mapping and making up 5 to 10 percent of the mapped areas are Mayer depressional soils. They are in small depressions and are subject to ponding.

Permeability is moderate in the loamy mantle and rapid in the underlying material. The available water

capacity is moderate to high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling wetness and maintaining fertility are concerns in management. Open ditches and subsurface drainage lines can adequately drain the excess water from this soil. Applications of fertilizer and manure and the return of crop residue to the soil maintain fertility and help offset the high content of lime. With fertilization and adequate drainage, this soil is highly productive.

The soil is well suited to use as pasture. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, fertilization, and restricted use during very wet periods help to maintain a stand of desirable grasses and to produce high yields of forage.

The soil has fair suitability for windbreaks and environmental plantings. Only trees and shrubs that are tolerant of high lime conditions should be planted, because the free carbonates in the soil tie up minerals and limit their availability. Species selected for planting should also be adapted to excess moisture conditions. Wetness causes moderate seedling mortality and can delay spring planting. Cultivation or herbicides help control competing vegetation, including weeds.

This soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without a basement, and landscaping should be designed to drain surface water away from the building. Tile drains around the foundation help remove excess subsurface water. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads caused by low soil strength and by frost action. This soil is poorly suited to use as septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal high water table at a depth of at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw.

260—Duelm loamy sand. This is a nearly level, somewhat poorly drained to moderately well drained soil on outwash plains. It is in broad, shallow, concave swales and on broad flats. The areas vary in shape and range from 3 to 40 acres in size.

Typically, the surface layer is black loamy sand about 12 inches thick. The subsurface layer is very dark gray loamy sand about 7 inches thick. The subsoil is about 19 inches thick. The upper part is dark grayish brown loamy sand, and the lower part is grayish brown, mottled coarse sand. The underlying material is pale brown,. mottled coarse sand to a depth of at least 60 inches. In some areas the surface layer and the subsoil have more clay. In some places the dark surface soil is more than 24 inches thick. Also, in some areas the subsoil and the underlying material are more than 15 percent gravel.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Dickman and Isan soils. Dickman soils are well drained; they are on slight rises and knolls. Isan soils are poorly drained and very poorly drained; they are in wet, concave swales.

Permeability is rapid. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow. The seasonal high water table is at a depth of 2 to 5 feet.

This soil is used mainly for crops. It is poorly suited to corn, small grains, and forage grasses and legumes. Droughtiness, seasonal wetness, maintaining fertility, and controlling soil blowing are concerns in management. Minimum tillage or a winter cover crop helps to conserve moisture and prevent soil blowing. A balanced fertilization program that includes applying manure and returning crop residue to the soil help improve fertility. Irrigation minimizes the effects of drought. This soil is especially well suited to irrigated truck crops. Center pivot and traveling gun irrigation systems are the types most commonly used. Crops respond well to irrigation.

The soil is fairly well suited to use as pasture. The main management concern is the hazard of drought. Overgrazing reduces the protective cover and causes the plant community to deteriorate. Pasture rotation, proper fertilization, liming, weed control, and proper stocking rates help to maintain a desirable plant community and to produce fair yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides help control competing vegetation, including weeds.

This soil is poorly suited to use as building sites because of wetness. Buildings on this soil should be built without a basement. Land shaping should be designed to drain surface water away from the building foundation. Tile drains around the foundation help remove excess subsurface water. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help overcome wetness and prevent damage to the roads by frost action. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent. Consequently, the ground water supply can become polluted. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that is placed on the surface.

This soil is in capability subclass IVs.

261—Isan loamy sand. This is a nearly level, poorly drained and very poorly drained soil on outwash plains. It is in wet, concave swales, drainageways, and depressions and on the edge of areas of very poorly drained organic soils or of marsh. The areas vary in shape and range from 3 to 20 acres in size. This soil is subject to ponding.

Typically, the surface layer is black loamy sand about 13 inches thick. The subsurface layer is very dark gray loamy sand about 7 inches thick. The subsoil is dark grayish brown, mottled coarse sand about 9 inches thick. The underlying material is grayish brown, mottled, noncalcareous sand to a depth of at least 60 inches. In some places, there is an organic surface layer as much as 16 inches thick.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Duelm soils. Duelm soils are somewhat poorly drained; they are on nearly level flats or on the rim of depressions.

Permeability is rapid. The available water capacity is low. The content of organic matter is moderate, and natural fertility is low. Surface runoff is slow or is ponded. The seasonal high water table is within 2 feet of the surface.

This soil is used mainly as pasture. It is well suited to use as pasture. Deferring grazing when the soil is wet helps to prevent compaction and impaired tilth and to increase the production of forage. Proper fertilization, weed control, and pasture rotation help maintain the soil and the pasture plants in good condition.

The soil is poorly suited to corn, small grains, and forage grasses and legumes. Management concerns are artificial drainage and maintenance of fertility and tilth. Open ditches are commonly used to lower the high seasonal water table and to prevent ponding, but in some areas there are no suitable drainage outlets. If this soil is used for cultivated crops, wind erosion is a hazard. Minimum tillage and winter cover crops help prevent excessive soil loss. A balanced fertilization program, applying manure, and returning crop residue improve fertility and tilth.

The soil is well suited to windbreaks and environmental plantings. However, only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe because of wetness and ponding. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as habitat for wetland wildlife. In many places more favorable conditions for wildlife can be provided by introducing suitable plant species and by excavating shallow ponds and ditches.

The soil generally is not suitable for building sites or septic tank absorption fields because of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads by ponding.

This soil is in capability subclass IVw.

281—Darfur coarse sandy loam. This is a nearly level, poorly drained soil in concave swales and drainageways on outwash plains. The areas vary in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black coarse sandy loam about 11 inches thick. The subsurface layer is very dark gray, mottled sandy loam about 6 inches thick. The subsoil is about 13 inches thick. The upper part is dark grayish brown, mottled loamy sand, and the lower part is grayish brown, mottled sandy loam. The underlying material is stratified, grayish brown and olive gray sandy loam, loamy sand, and sand to a depth of at least 60 inches. In some areas, there are no bands of finer textured material. In places, the loamy mantle is coarser textured than is typical. In some areas the soil is somewhat poorly drained.

Included with this soil in mapping and making up 5 to 15 percent of some mapped areas are small areas of Dickman, Litchfield, and Ridgeport soils. Dickman and Litchfield soils are in higher lying positions within the mapped areas. Dickman soils are well drained and do not have bands of finer textured material. Litchfield soils are moderately well drained. Ridgeport soils are well drained; they are on knolls.

Permeability is moderate to moderately rapid in the upper part of this soil and moderately rapid in the lower part. The available water capacity is low. The content of organic matter is high, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops and pasture. It is well suited to corn, small grains, and forage grasses and legumes. The major concerns in management are wetness and low natural fertility. If this soil is artificially drained, droughtiness is an added concern. Proper drainage, use of fertilizers, return of crop residue, and crop rotation help maintain tilth and fertility. Selection of crops that tolerate wetness and can withstand ponding for short periods is important. Liming increases the effectiveness of fertilizers and helps to establish legume stands.

The soil is fairly well suited to use as pasture. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, liming, fertilization, and restricted use during very wet periods help to maintain the desirable grasses and to produce high yields of forage.

The soil is well suited to windbreaks and environmental plantings. Only trees and shrubs that tolerate excess moisture conditions should be selected for planting. Wetness causes moderate seedling mortality and can delay spring planting. Cultivation or herbicides can help to control competing vegetation.

The soil is poorly suited to use as building sites because of wetness. Buildings constructed on this soil

should be built without a basement, and land shaping should be designed to drain surface water away from the building foundation. Tile drains around the foundation help to remove excess subsurface water. Constructing roads on well compacted, coarse textured base material helps prevent damage to the roads by frost action. The soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that is placed on the surface.

This soil is in capability subclass IIIw.

292B—Alstad sandy loam, 1 to 4 percent slopes. This is a nearly level to undulating, somewhat poorly drained soil on ground and end moraines. It is on flats and on the lower part of side slopes. The areas vary in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark brown sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, mottled sandy loam about 6 inches thick. The subsoil is about 33 inches thick. The upper part is dark brown, mottled sandy clay loam, and the lower part is dark brown, mottled sandy loam. The underlying material is dark brown, noncalcareous sandy loam to a depth of at least 60 inches. In some places, the subsoil has less clay than is typical and does not have a very firm and dense layer. Also, in some places the surface soil and subsoil have a higher content of silt. In some areas the soil is moderately well drained.

Included with this soil in mapping and making up 5 to 10 percent of some mapped areas are small areas of Prebish soils, which are very poorly drained. Prebish soils are in depressions and drainageways.

Permeability and the available water capacity are moderate. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow to medium. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops or pasture. It is well suited to corn, small grains, and forage grasses and legumes. The major concerns in management are erosion, clearing trees and stones from the soil, and seasonal wetness. The seasonal high water table delays fieldwork early in spring. Stones in this soil are brought to the surface by tillage and by frost action. Tillage is easier and equipment is less likely to be damaged if the stones are removed periodically. Returning crop residue and applying manure to the soil help to maintain tilth and fertility and also to conserve moisture. Liming increases the effectiveness of fertilizer and helps improve grass and legume stands.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major management concern. Site preparation, cultivation, and cutting, spraying, girdling, or prescribed burning help control competing vegetation.

The soil is poorly suited to use as building sites because of wetness. Buildings on this soil should be built without basements, and land shaping should be designed to drain surface water away from the building foundation. Tile drains around the foundation help to remove excess subsurface water. Constructing roads on well compacted, coarse textured base material helps prevent damage to the roads by frost action. The soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that is placed on the surface.

This soil is in capability subclass IIe and in woodland suitability group 2o.

318—Mayer loam, depressional. This is a nearly level, very poorly drained, calcareous soil in shallow depressions and in drainageways of sluggish streams. The individual areas vary in shape and range from 3 to 15 acres in size. This soil is subject to ponding.

Typically, the surface layer is black and very dark gray loam about 24 inches thick. The subsoil is dark gray and gray, mottled loam about 16 inches thick. The underlying material is olive gray coarse sand to a depth of at least 60 inches. In some places, the depth to sand and gravel is less than 20 inches. In some areas there is an accumulation of lime in the surface layer. Also, in some places there is as much as 16 inches of muck overlying the mineral soil.

Permeability is moderate in the loamy upper part and rapid in the underlying material. The available water capacity is moderate. The content of organic matter and natural fertility are high. Surface runoff is slow or is ponded. The water table is within 1 foot of the surface throughout the year.

In most areas this soil is used for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. However, alfalfa can drown out or be short-lived. Wetness and ponding are major concerns in management; also, the alkalinity of this soil can cause a fertility imbalance. Wetness and ponding can be controlled, where outlets are available, by open ditches and subsurface drainage lines with surface inlets. Removing excess water permits earlier planting and minimizes flooding of crops. Maintaining a proper balance of nutrients by fertilization can minimize lodging of small grains and permit corn to reach maturity.

The soil is fairly well suited to use as pasture, but artificial drainage generally is needed. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, fertilization, and restricted use during wet periods help establish and maintain desirable grasses for forage production.

The soil has fair suitability for windbreaks and environmental plantings. However, only those trees and shrubs that tolerate wet soil conditions should be selected for planting. Seedling mortality is severe because of wetness. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is not suitable for building sites or septic tank absorption fields because of wetness and ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads by ponding and frost action.

This soil is in capability subclass IIIw.

325—Prebish sandy loam, depressional. This is a level, very poorly drained soil on drumlin fields and on ground and end moraines. It is in slightly concave shallow depressions, swales, and on the margin of bogs. It is subject to ponding. The areas vary in shape and range from 4 to 20 acres in size.

Typically, the surface layer is black sandy loam about 13 inches thick. The subsurface layer is black sandy loam about 5 inches thick. The subsoil is about 29 inches thick. It is dark grayish brown, mottled sandy loam in the upper part and grayish brown, mottled sandy loam and loam in the lower part. The underlying material is dark brown, mottled, noncalcareous sandy loam to a depth of at least 60 inches. In places the depth to firm till is shallower than is typical. Also, in some areas next to outwash soils, the surface layer is coarser textured.

Included with this soil in mapping and making up 2 to 15 percent of some mapped areas are small areas of Brainerd, Cathro, and Nokay soils. Brainerd soils are moderately well drained. They are next to depressions in more sloping areas than the Prebish soil. Cathro soils are very poorly drained; they are in depressions. They formed in organic material. Nokay soils are somewhat poorly drained. They are on flats and rises along the rim of depressions.

Permeability is moderately slow. Surface runoff is very slow or is ponded. The available water capacity is moderate. The content of organic matter is high, and natural fertility is medium. The seasonal high water table is within 1 foot of the surface.

This soil is used mainly as pasture. It is fairly well suited to use as pasture. In some areas the soil remains in native vegetation. Artificial drainage is necessary on this soil because ponding is a problem. Grazing when the soil is wet or overgrazing causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, fertilization, and restricted use during wet periods help establish and maintain desirable grasses for forage production. Because adequate drainage outlets are not available, many areas of this soil currently are being used for wild hay or as unimproved pasture.

This soil is poorly suited to corn, small grains, and forage grasses and legumes. The major limitations are ponding, wetness, and frost. The seasonal high water table is a management concern, but the problem can be corrected by adequate drainage; outlets, however, are difficult to establish. Diversions and surface drainage can reduce ponding. Because of the soil's low position on the landscape, frost is a hazard late in spring and early in fall. Stones also are a limitation. They can make tillage operations difficult.

This soil is fairly well suited to trees and shrubs in windbreaks and environmental plantings. Only trees and shrubs that can tolerate excess moisture should be selected. Seedling mortality is high because the soil is very poorly drained. Cultivation or herbicides help control weeds and other competing vegetation.

This soil is well suited to use as habitat for wetland wildlife. Impoundments and shallow dugouts are suitable for migratory waterfowl, and elongated channels are suitable for furbearing animals.

This soil generally is not suitable for use as building sites or septic tank absorption fields because of ponding. Roads on this soil should be constructed on raised, coarse-textured fill material, and there should be adequate side ditches and culverts to help prevent damage to the roads by ponding and frost action.

This soil is in capability subclass IVw.

327A—Dickman sandy loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on broad flats on outwash plains and stream terraces. The areas vary in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is about 20 inches thick. The upper part is dark yellowish brown sandy loam, and the lower part is dark yellowish brown sand. The underlying material is dark yellowish brown coarse sand to a depth of at least 60 inches. In some places, the surface layer is more than 16 inches thick. Also, in some places, the underlying material is mildly alkaline or moderately alkaline at a depth of less than 48 inches.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Duelm and Hubbard soils. Duelm soils are moderately well drained to somewhat poorly drained. They are in lower positions on the landscape than the Dickman soil. Hubbard soils are excessively drained; they are on the most exposed convex rises.

Permeability is moderately rapid in the upper part and rapid in the underlying material. The available water capacity is low. The content of organic matter is moderate, and natural fertility is low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

Most areas of this soil are used for crops. This soil is fairly well suited to corn, small grains, and forage grasses and legumes. The main management concerns are overcoming droughtiness, improving fertility, and reducing soil blowing. Minimum tillage or a winter cover crop helps conserve moisture and also reduces the hazard of soil blowing. Fertilizers, manure, and crop residue on the surface help improve fertility. Irrigation can minimize the effects of drought. Under irrigation, this soil is especially well suited to truck crops. Center pivot and traveling gun irrigation systems are the types most commonly used.

This soil is fairly well suited to use as pasture. The main concern in management is droughtiness. Overgrazing reduces the protective cover and causes the plant community to deteriorate as the less desirable species become established. Pasture rotation, proper fertilization, weed control, and proper stocking rates help maintain productive forage grasses. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the summer.

This soil is well suited to windbreaks and environmental plantings. Only trees and shrubs that can tolerate droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Cultivation and herbicides help control weeds and other competing vegetation.

This soil is well suited to building site development and local roads. This soil readily absorbs but does not adequately filter effluent from septic tanks. Consequently, the ground water supply can become polluted. In a septic tank absorption field, there should be at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIs.

327B—Dickman sandy loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil. It is on crests and concave side slopes on outwash plains and stream terraces. The areas vary in shape and range from 3 to 30 acres in size.

Typically, the surface layer is very dark brown sandy loam about 10 inches thick. The subsurface layer is dark brown sandy loam about 4 inches thick. The subsoil is about 17 inches thick. It is dark yellowish brown coarse sandy loam in the upper part, brown and dark brown coarse sand in the middle part, and yellowish brown sand in the lower part. The underlying material is brown coarse sand to a depth of at least 60 inches. In some places, the surface layer is less than 10 inches thick or more than 18 inches thick. Also, in some places, the underlying material is mildly alkaline or moderately alkaline at a depth of less than 48 inches.

Included with this soil in mapping and making up 2 to 5 percent of the map unit are small areas of Hubbard soils. Hubbard soils are excessively drained. They are on the most exposed crests and on convex side slopes.

Permeability is moderately rapid in the upper part and rapid in the underlying material. The available water capacity is low. The content of organic matter is moderate, and natural fertility is low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. Management concerns are controlling erosion, overcoming droughtiness, and improving fertility. Minimum tillage or a winter cover crop helps conserve moisture and reduces the hazard of soil blowing. A balanced fertilization program, in addition to applying manure, and leaving crop residue on the surface help improve fertility. Irrigation can minimize the effects of drought. Center pivot and traveling gun irrigation systems are the types most commonly used.

This soil is fairly well suited to use as pasture. Droughtiness is a major concern. Overgrazing reduces the protective cover and causes the plant community to deteriorate as the less desirable species become established. Consequently, the hazard of erosion is increased. Pasture rotation, proper fertilization, weed control, and proper stocking rates help maintain productive forage grasses. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the summer.

This soil is well suited to trees and shrubs in windbreaks and environmental plantings. Trees and shrubs that can tolerate droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Cultivation and herbicides help remove competing vegetation, including weeds.

This soil is well suited to building site development and local roads. This soil readily absorbs but does not adequately filter effluent from septic tanks. Consequently, the ground water supply can become polluted. In a septic tank absorption field, there should be at least 6 inches of sandy loam or loam between the point where the effluent enters the soil and the

underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material tht has been placed on the surface.

This soil is in capability subclass IIIe.

392—Biscay loam. This is a nearly level, poorly drained soil. It is in drainageways and concave swales on outwash plains and stream terraces. The areas vary in shape and range from 3 to 20 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray loam and is also about 8 inches thick. The subsoil is gray, mottled loam about 10 inches thick. The underlying material is olive gray, calcareous coarse sand and gravelly coarse sand to a depth of at least 60 inches. In some places, the sandy material is at a depth of less than 20 inches, or the surface layer and subsurface layer combined are more than 24 inches thick. In some places, there is lime in the upper part of the soil.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of the depressional phase of Mayer and Biscay soils. These soils are very poorly drained and are subject to ponding. They are in small depressions.

Permeability is moderate in the loamy mantle and rapid in the underlying material. The available water capacity is moderate to high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

Most areas of this soil are used for crops. This soil is well suited to corn, small grains, and forage grasses and legumes. Controlling wetness and maintaining fertility are concerns in management. If outlets are available, open ditches and subsurface drainage lines can adequately drain excess water. Returning crop residue to the soil and applying manure help maintain or improve fertility and conserve moisture in the rooting zone.

This soil is well suited to use as pasture. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, fertilization, and restricted use during very wet periods help to maintain the more desirable grasses and to produce high yields of forage.

This soil is well suited to trees and shrubs in windbreaks and in environmental plantings. Trees and shrubs that can tolerate excess moisture should be selected. Seedling mortality is moderate because the soil is poorly drained. The excess moisture in the soil can delay spring planting. Competing vegetation, including weeds, can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without a basement, and landscaping should be designed to drain surface water away from the building. Tile drains around the foundation help remove excess subsurface water. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads caused by low soil strength and by frost action. This soil is poorly suited to use as septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal water table at a depth of at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw.

399—Biscay loam, depressional. This is a level, very poorly drained soil in depressions. It is subject to ponding. The areas of this soil vary in shape and range from 3 to 15 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is black sandy clay loam about 14 inches thick. The subsoil is olive gray, mottled sandy clay loam about 4 inches thick. The underlying material extends to a depth of at least 60 inches. In the upper part it is dark grayish brown, mottled sand, and in the lower part it is olive gray, mottled, calcareous coarse sand. In some places, the sandy material is at a depth of less than 20 inches. Also, in some places there is lime in the loamy mantle. In other places, there is up to 16 inches of muck on the surface.

Permeability is moderate in the loamy part and rapid in the underlying material. The available water capacity is moderate to high. The content of organic matter and natural fertility are high. Surface runoff is slow or is ponded. The seasonal high water table is at a depth of less than 3 feet.

This soil is used mainly for crops. With proper management, this soil is fairly well suited to corn, small grains, and forage grasses and legumes. Alfalfa can drown out or be short-lived because of wetness. The main concerns in management are excess water and fertility; the content of lime in the lower part of the soil can bring about a fertility imbalance. Wetness and ponding can be controlled by adequate artificial drainage. If outlets are available, open ditches and subsurface drainage lines that have surface inlets remove excess water. Drainage permits earlier planting and minimizes damage to crops. Maintaining a proper balance of nutrients by adding suitable fertilizers minimizes lodging of small grains and permits corn to reach maturity.

This soil is well suited to use as pasture if adequate artificial drainage is provided. Grazing when the soil is wet or overgrazing causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, fertilizatión, and restricted use during wet periods help establish and maintain the more desirable grasses for high yields of forage.

This soil is poorly suited to windbreaks and environmental plantings. Only trees and shrubs that can tolerate excess moisture should be selected for planting. Seedling mortality is severe because the soil is very poorly drained. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is generally not suitable for use as building sites or as septic tank absorption fields because ponding is a hazard. Roads on this soil, to protect them from damage caused by ponding, frost action, and low soil strength, should be constructed on raised, coarse textured fill material, and there should be adequate side ditches and culverts.

This soil is in capability subclass IIIw.

406B—Dorset sandy loam, 2 to 8 percent slopes. This is an undulating, well drained soil on outwash plains and stream terraces. It is on knolls and concave side slopes. The areas vary in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsurface layer is dark brown sandy loam about 3 inches thick. The subsoil is about 13 inches thick. It is dark brown and strong brown sandy loam in the upper part and dark brown loamy sand in the lower part. The underlying material is brown, calcareous gravelly coarse sand to a depth of at least 60 inches. In some places the subsoil is thicker than is typical, and free lime is at a greater depth. Also, in some places, the texture is coarser, and the underlying calcareous material is at a greater or lesser depth than is typical.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of Biscay, Nymore, and Regal soils. Biscay and Regal soils are poorly drained. They are in lower concave positions. Nymore soils are excessively drained and are sandy throughout. They are in convex areas.

Permeability is moderately rapid in the upper part of the Dorset soil and rapid in the lower part. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. Because the soil is droughty, good management is needed to sustain yields and to prevent excessive soil loss. Fertilizer, manure, and crop residue left on the surface improve fertility and tilth. Minimum tillage, no-till planting, crop rotation, and contour farming commonly are used to control runoff and erosion. Providing supplemental water by irrigation is desirable but is not practicable because of the complex soil and slope patterns. Growing shallow-rooted crops that mature early helps offset the effects of occasional periods of drought late in the growing season.

This soil is fairly well suited to use as pasture. Deferring grazing early in spring and late in fall allows the pasture plants to regain vigor and helps reduce losses from winterkill, trampling, and compaction. Forage production can be increased by including grass-legume pasture in a crop rotation rather than maintaining permanent bluegrass pasture. A permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months. Permanent pasture of these grasses should be divided, and grazing should be rotated.

This soil is fairly well suited to windbreaks and environmental plantings. Trees and shrubs that can withstand droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Cultivation and herbicides help remove competing vegetation, including weeds.

This soil is fairly well suited to use as woodland. Seedling mortality is severe because of droughtiness and soil blowing. Only those species that can withstand drought and tolerate limy soil should be selected for planting. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining a vegetative cover on adjacent fields. Reinforcement planting may be necessary.

This soil is well suited to building site development. Erosion is a moderate hazard during construction. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that is placed on the surface.

This soil is in capability subclass IIIs and in woodland suitability group 3s.

406C—Dorset sandy loam, 8 to 15 percent slopes. This is a rolling, well drained soil. It is on knolls and concave side slopes on outwash plains and stream terraces. The areas vary in shape and range from 3 acres to 30 acres in size.

Typically, the surface layer is dark brown sandy loam about 6 inches thick. The subsoil is about 13 inches thick. It is dark yellowish brown sandy loam in the upper part and dark brown loamy sand in the lower part. The underlying material is dark yellowish brown and brown, calcareous coarse sand and gravelly coarse sand to a depth of at least 60 inches. In some places the subsoil is thicker than is typical, and free lime is at a greater depth. Also, in some places, the texture is coarser, and the

depth to the calcareous underlying material is greater or less than is typical.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Biscay, Nymore, and Regal soils. Biscay and Regal soils are poorly drained and are on the lower, concave part of slopes. Nymore soils are excessively drained and are sandy throughout. They are on convex slopes.

Permeability is moderately rapid in the upper part and rapid in the lower part. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow to medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops, but it is poorly suited to row crops and small grains. It is suited to forage grasses and legumes. Because the soil is droughty, good management is needed for sustained crop production and to prevent excessive soil loss. A balanced fertilizer program, applications of manure, and crop residue left on the soil improve fertility and tilth. Minimum tillage, no-till planting, crop rotation, and contour farming commonly are used to control runoff and soil erosion. Shallow-rooted crops that mature early in the growing season are more reliable for production than late-season crops, which may encounter drought.

This soil is fairly well suited to use as pasture. Deferring grazing early in spring and late in fall allows the pasture plants to regain vigor and reduces loss from winterkill, trampling, and compaction. Forage production can be increased by using grass-legume pasture in a crop rotation rather than maintaining permanent bluegrass pasture. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months. Permanent pasture of these grasses should be divided for rotation grazing.

This soil is fairly well suited to windbreaks and environmental plantings. Trees and shrubs that can tolerate droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Cultivation and herbicides help remove competing vegetation, including weeds.

This soil is fairly well suited to use as woodland. Seedling mortality is severe because of droughtiness and soil blowing. Only trees that can tolerate droughtiness and calcareous conditions in the root zone should be selected for planting. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Mulching around the seedlings and maintaining a vegetative cover on adjacent fields help control soil blowing. Replacement of some seedlings may be necessary.

This soil is well suited to building site development. Erosion is a hazard during construction. Land shaping may be necessary in some areas. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material placed on the surface.

This soil is in capability subclass IVe and in woodland suitability group 3s.

406E—Dorset sandy loam, 15 to 25 percent slopes. This is a hilly to steep, well drained soil. It is on hillsides on outwash plains and stream terraces. The areas vary in shape and range from 5 to 60 acres in size.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsoil is about 13 inches thick. It is dark yellowish brown sandy loam in the upper part and yellowish brown loamy sand in the lower part. The underlying material is yellowish brown, calcareous coarse sand to a depth of 60 inches or more. In some places the subsoil is thicker, and free lime is at a greater depth. On the crest of some slopes, the texture is coarser, and the depth to the underlying calcareous material is less.

Included with this soil in mapping and making up to 15 percent of some mapped areas are small areas of Nymore and Hawick soils, which are excessively drained. Nymore soils are on the crest of slopes, and Hawick soils are in convex areas at the top of the steep slopes.

Permeability is moderately rapid in the upper part and rapid in the lower part. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture. It is poorly suited to use as pasture. Management concerns are the hazard of erosion, the low available water capacity and low natural fertility, and a canopy of trees that blocks the sunlight. Selective tree removal to improve light conditions, seeding warm-season grasses that provide forage all summer, and topdressing with fertilizer produce higher yields of forage and, consequently, help reduce rainfall runoff. The soil is generally not suited to row crops and small grains because erosion is a severe hazard.

This soil is poorly suited to windbreaks and environmental plantings. Only trees and shrubs that can tolerate droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Water erosion is severe unless the area is kept vegetated; therefore, site preparation should be restricted to the area within 2 feet of the planting. Cultivation and herbicides help remove competing vegetation, including weeds.

This soil is poorly suited to use as woodland. Seedling mortality is severe because of droughtiness and soil

blowing. Only trees that can withstand droughtiness and are adapted to calcareous conditions in the root zone should be selected for planting. Shallow tillage, mulching, and timely planting help to conserve moisture and to reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining a vegetative cover on adjacent fields. Water erosion can be controlled by maintaining an adequate ground cover.

Slope is a limitation to the use of this soil as building sites. Erosion is a severe hazard. Extensive land shaping generally is needed. Buildings and lots should be designed to conform to the natural slope. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to control erosion. This soil generally is not suited to septic tank absorption fields because of the steep slopes and because the soil does not adequately filter the effluent.

This soil is in capability subclass VIe and in woodland suitability group 3s.

413—Osakis loam. This is a nearly level, moderately well drained soil on concave slopes and in swales. The areas vary in shape and range from 5 to 200 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is dark yellowish brown and is about 11 inches thick. It is sandy loam in the upper part and mottled loamy coarse sand in the lower part. The underlying material is grayish brown, mottled, calcareous coarse sand and grayish brown, calcareous gravelly coarse sand to a depth of at least 60 inches. In some places, the depth to sandy and gravelly material is less than 16 inches or more than 30 inches. Also, in places there is more gravel in the underlying material.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of Estherville and Regal soils. Estherville soils are somewhat excessively drained and are on the higher convex rises. Regal soils are poorly drained and are in concave swales and small depressions.

Permeability is moderate to moderately rapid in the upper part and rapid in the lower part. The available water capacity is low. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth between 4 and 6 feet, but it drops considerably during extended dry periods.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. Conserving moisture, maintaining fertility levels, controlling erosion, and irrigating as needed are concerns in management. Minimum tillage or a winter cover crop helps to conserve moisture and to prevent soil blowing. Fertilizers, manure, and crop residue left on the soil help improve fertility. Irrigation minimizes the effects of drought. The soil is especially well suited to irrigated truck crops. Center pivot and traveling gun irrigation systems are the types most commonly used on this soil. Crops respond well to irrigation.

This soil is fairly well suited to use as pasture. The main concern in management is droughtiness. Overgrazing reduces the protective cover and causes the plant community to deteriorate as the less desirable species increase. Pasture rotation, proper fertilization, weed control, and proper stocking rates help maintain a desirable plant community and help produce good yields of forage. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

This soil is well suited to a wide variety of trees and shrubs that can be used in windbreaks and environmental plantings. Cultivation or herbicides can help remove competing vegetation, including weeds.

This soil is suitable for building site development; however, wetness is a concern. The lower or basement level of a building should be constructed above the seasonal high water table. Tile drains around the foundation help remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not filter the effluent adequately. Consequently, the ground water supply can become polluted. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIs.

414—Hamel loam. This is a nearly level, poorly drained soil on ground and end moraines. It is in drainageways and swales and on toe slopes. The areas vary in shape and range from 3 to 10 acres in size.

Typically, the surface layer is black loam about 12 inches thick. The subsurface layer is black clay loam about 11 inches thick. The subsoil is 18 inches thick. It is very dark gray clay loam in the upper part, olive gray, mottled loam in the middle part, and olive gray, mottled loam in the lower part. The underlying material is olive gray, mottled, calcareous loam to a depth of 60 inches or more. In some places, the subsoil is brighter in color and is free of mottles to a greater depth. In other places, it is not so well developed. Also, in some places, the dark color of the surface soil extends to a depth of less than 24 inches.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of Normania, Gonvick, and Marcellon soils. Gonvick, Marcellon, and Normania soils are moderately well

drained. They are at the base of steeper slopes and are in higher positions on the periphery of the mapped areas.

Permeability is moderately slow, and the available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow to medium. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling wetness and maintaining fertility are concerns in management. Where outlets are available, open ditches and subsurface drainage lines can adequately drain excess water from this soil. Crop residue left on the soil and applications of fertilizer and manure help maintain or improve fertility.

This soil is well suited to use as pasture. Grazing when wet and overgrazing, however, cause surface compaction and poor soil tilth. Proper stocking rates, pasture rotation, fertilization, and restricted use during very wet periods help maintain grasses for high yields of quality forage.

This soil is well suited to windbreaks and environmental plantings. Trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is moderate because of wetness, and spring planting may be delayed. Cultivation or herbicides can help remove competing vegetation, including weeds.

This soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without a basement, and land shaping should be designed to drain surface water away from the buildings. Tile drains around the foundation help remove excess subsurface water. Constructing roads on well compacted, coarse textured base material helps prevent damage to the roads caused by low strength and frost action. The soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw.

421B—Ves loam, 2 to 6 percent slopes. This is an undulating, well drained soil. It is on knolls that have convex and concave side slopes. The areas vary in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark brown loam about 4 inches thick. The subsoil is dark brown loam about 14 inches thick. The underlying material is light olive brown, calcareous loam to a depth of 60 inches or more. In some places, the surface soil is thinner, or it is mixed with the brownish subsoil. Also, on some convex knolls the surface layer is light in color and has a high content of lime. In some areas, there is no accumulation of lime in the upper part of the underlying material.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of Flom and Hamel soils. Flom and Hamel soils are poorly drained. They are in concave swales and on toe slopes.

Permeability is moderate, and the available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling erosion and maintaining fertility and tilth are the main concerns in management. The undulating slopes generally are not well suited to terracing and contour farming. Crop residue left on the surface and proper crop rotation are effective in controlling erosion and improving tilth. Crops respond well to applications of fertilizer. Grassed waterways are needed in some places to stop gullying. Stones and boulders are occasionally brought to the surface by tillage or by frost action. Tillage is simplified and there is less risk of damage to equipment if the stones and boulders are removed periodically.

This soil is well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help to maintain a desirable plant community and to produce high yields of forage. Overgrazing causes soil compaction and increased runoff and reduces the quality of forage.

This soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides can help remove competing vegetation, including weeds.

This soil is well suited to building site development. Roads should be constructed on well compacted, coarse textured fill material to help prevent damage to the roads caused by low strength and by frost action. The soil is suitable for use as septic tank absorption fields.

This soil is in capability subclass IIe.

421C—Ves loam, 6 to 12 percent slopes. This is a rolling, well drained soil on convex ridges and knolls on ground and end moraines. The areas vary in shape and range from 3 to 15 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsoil is loam and is about 16 inches thick. The upper part is dark brown or brown, and the lower part is olive brown. The underlying material is light olive brown, calcareous loam to a depth of at least 60 inches. It has an accumulation of lime in the upper part. In some places, the surface layer is thinner, or it is mixed, through plowing, with the brownish subsoil. In some areas there is no accumulation of lime in the upper part of the underlying material.

Included with this soil in mapping and making up 5 to 10 percent of the mapped areas are small areas of Storden soils. Storden soils are well drained and do not have a dark surface layer. They are on the most exposed, convex part of slopes.

Permeability is moderate, and the available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is medium. The seasonal high water table is at depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Erosion control and maintenance of fertility and tilth are major concerns in management. Minimum tillage, stripcropping, and proper crop rotation are effective in controlling erosion. In places, grassed waterways are needed to control gullying. A balanced fertilization program, applications of manure, and crop residue left on the surface help improve fertility and tilth.

This soil is well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help maintain a desirable plant community and high yields of forage. Overgrazing should be avoided because it causes soil compaction and increased runoff and reduces the quality of forage.

This soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides can help remove competing vegetation, including weeds.

This soil is well suited to building site development. Erosion is a moderate hazard during construction. Land shaping may be necessary in some areas. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by low strength and by frost action. Constructing roads on the contour wherever possible and planting roadbanks to well-adapted grasses help control erosion. This soil is suited to septic tank absorption fields. However, land shaping and installing the distribution lines on the contour generally are necessary for the proper operation of the absorption field.

This soil is in capability subclass IIIe.

446A—Normania loam, 1 to 3 percent slopes. This is a nearly level, moderately well drained soil. It is on smooth, broad flats and on low, convex rises on ground and end moraines. The areas vary in shape and range from 3 to 100 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The next layer is very dark brown loam about 5 inches thick. The subsoil is olive brown loam about 12 inches thick and, typically, is mottled in the lower part. The underlying material is light olive brown loam to a depth of at least 60 inches. There is an accumulation of lime in the upper part, and the lower part is mottled. In some places, the surface layer is thinner. The depth to lime varies considerably.

Included with this soil in mapping and making up 5 to 10 percent of the mapped areas are small areas of Bluffton and Flom soils. Bluffton soils are very poorly drained and are in small, closed depressions. Flom soils are poorly drained and are in concave swales and drainageways.

Permeability of this soil is moderate. The available water capacity is high. Natural fertility and the content of organic matter are high. Surface runoff is slow. The seasonal high water table is at a depth of 3 to 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Minimum tillage, applications of manure, and crop residue left on the soil help improve fertility and tilth and help conserve moisture. Crops respond well to a balanced fertilization program.

This soil is well suited to use as pasture. Fertilization, weed control, and pasture rotation help maintain a desirable plant community that affords high yields of forage.

This soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides can help to remove competing vegetation, including weeds.

This soil is well suited to building site development. Wetness is a limitation for buildings with basements. The lower or basement level should be constructed above the seasonal high water table, or tile drains should be placed around the foundation to remove excess subsurface water. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability class I.

446B—Normania loam, 3 to 5 percent slopes. This is an undulating, moderately well drained soil that is on a series of convex rises, ridges, and knolls, which, in places, have sharply breaking, concave side slopes. The areas vary in shape and range from 5 to 200 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is about 13 inches thick. The upper part is dark brown loam, and the lower part is olive brown, mottled loam. The underlying material is light olive brown, calcareous loam to a depth of 60 inches or more. It has an accumulation of lime in the upper part. In some places the surface layer is thinner, or it is mixed with the brownish subsoil. Also, on some convex knobs the surface layer is light in color and high in lime.

Included with this soil in mapping and making up 10 to 15 percent of the mapped areas are small areas of Flom and Hamel soils. Flom and Hamel soils are poorly drained and are in drainageways and concave swales.

Permeability is moderate, and the available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is medium. The seasonal high water table is at a depth of 3 to 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling erosion and maintaining fertility and tilth are the main concerns in management. Minimum tillage, crop residue left on the surface, and proper crop rotation are effective in controlling erosion and improving tilth. In places, grassed waterways are needed to stop gullying. Crops respond well to a balanced fertilization program.

This soil is well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help to maintain a desirable plant community and to produce high yields of forage. Overgrazing causes soil compaction and increased runoff and reduces the quality of forage.

This soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides can help to remove competing vegetation, including weeds.

This soil is well suited to building site development. Wetness is a limitation for buildings with basements. The lower or basement level should be constructed above the seasonal high water table, or tile drains should be placed around the foundation to remove excess subsurface water. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that is placed on the surface.

This soil is in capability subclass IIe.

453B—DeMontreville loamy sand, 2 to 8 percent slopes. This is an undulating, well drained soil on ground and end moraines. It is on convex and concave knolls and on side slopes. The areas vary in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 7 inches thick. The subsurface layer is about 21 inches thick. It is dark brown loamy sand and coarse sand. The subsoil is dark brown sandy loam about 17 inches thick. The underlying material is dark brown, noncalcareous sandy loam to a depth of 60 inches or more. In some areas the sandy mantle is more than 40 inches thick.

Included with this soil in mapping and making up 5 to 15 percent of some mapped areas are small areas of Cushing, Nokay, and Prebish soils. Cushing soils are well drained. They developed in sandy loam glacial till and are in positions on the landscape similar to those of the DeMontreville soil. Nokay soils are somewhat poorly drained, and Prebish soils are very poorly drained. Nokay and Prebish soils are closely intermingled in depressions and drainageways.

Permeability is rapid in the upper part and moderately slow in the lower part. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow to medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. The major management concerns are the hazard of erosion, drought, and stones on the surface. Minimum tillage, contour farming, crop residue left on the surface, applications of manure, and crop rotation are effective in controlling erosion, maintaining tilth and fertility, and conserving moisture. Grassed waterways help prevent excessive soil loss. In places, stones on the surface interfere with cultivation and should be removed periodically. Applications of lime increase the effectiveness of fertilizers and improve grass and legume stands.

This soil is fairly well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant in the hot months.

This soil is fairly well suited to windbreaks and environmental plantings. Only trees and shrubs that can withstand droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is fairly well suited to use as woodland. Droughtiness and soil blowing cause moderate seedling mortality. Only trees that can withstand droughty conditions should be selected for planting. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining vegetative cover on adjacent fields. Some replacement of seedlings may be necessary.

This soil is well suited to building site development and to local roads. Because of the moderately slow permeability in the lower part, this soil does not readily take up the effluent from a septic tank absorption field. A larger than average drain field can help overcome this limitation.

This soil is in capability subclass IIIs and in woodland suitability group 3s.

453C—DeMontreville loamy sand, 8 to 15 percent slopes. This is a rolling, well drained soil on ground and end moraines. It is on convex and concave side slopes of ridges and knolls. The areas vary in shape and range from 3 to 25 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 7 inches thick. The subsurface layer is dark brown loamy sand and coarse sand and is about 21 inches thick. The subsoil is dark brown sandy loam about 17 inches thick. The underlying material is dark brown, noncalcareous sandy loam to a depth of 60 inches or more. In some places the sandy mantle is more than 40 inches thick.

Included with this soil in mapping and making up 5 to 15 percent of some mapped areas are small areas of Cushing, Nokay, and Prebish soils. Cushing soils are well drained and developed in sandy loam glacial till in positions similar to those of the DeMontreville soil. Nokay soils are somewhat poorly drained, and Prebish soils are very poorly drained; they are closely intermingled in depressions and drainageways.

Permeability is rapid in the upper part of this soil and moderately slow in the lower part. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture and woodland. The soil is poorly suited to corn and small grains. The hazards of erosion and drought and stones on the surface are the major concerns in management. Minimum tillage, contour farming, crop residue left on the surface, applications of manure, and a crop rotation that includes grasses and legumes are effective in controlling erosion and maintaining tilth and fertility and also help conserve moisture. In some places, stones interfere with cultivation and should be removed periodically. Grassed waterways help prevent excessive soil loss. Applications of lime increase the effectiveness of fertilizers and improve legume stands.

This soil is fairly well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help maintain a desirable plant community and produce high yields of forage. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

This soil is fairly well suited to windbreaks and environmental plantings. Only trees and shrubs that can withstand droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is fairly well suited to use as woodland. Seedling mortality is moderate because of droughtiness and soil blowing. Only trees that can withstand droughty conditions should be selected for planting. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and by maintaining a vegetative cover on adjacent fields. Replacement of some seedlings may be necessary.

This soil is well suited to building site development. Erosion is a hazard during construction. Land shaping may be necessary in some areas. Roads should be placed on the contour wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil does not readily absorb the effluent from a septic tank absorption field because of the moderately slow permeability in the lower part of the soil. A larger than average drain field helps overcome this limitation.

This soil is in capability subclass IVe and in woodland suitability group 3s.

454B—Mahtomedi loamy coarse sand, 2 to 8 percent slopes. This is an undulating, excessively drained soil on convex and concave side slopes of knolls on ground moraines and outwash plains. The areas vary in shape and range from 4 to 40 acres in size.

Typically, the surface layer is black loamy coarse sand about 3 inches thick. The subsurface layer is very dark grayish brown coarse sand about 5 inches thick. The subsoil is dark brown coarse sand about 26 inches thick. The underlying material is stratified, brown, noncalcareous coarse sand to a depth of at least 60 inches. In some areas, there are subhorizons that are less than 10 percent or more than 35 percent coarse fragments. In some areas, there is a discontinuous layer of finer textured material in the soil.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of Chetek, Cushing, DeMontreville, Flak, and Holdingford soils. Chetek soils formed in a loamy mantle over sandy or sandy-skeletal glacial outwash. Cushing and Flak soils formed entirely in loamy glacial till. DeMontreville soils have an upper sandy mantle that is 20 to 40 inches thick. Holdingford soils have calcareous underlying material at a depth of 26 to 60 inches. All of these soils are in positions on the landscape similar to those of the Mahtomedi soil.

Permeability is rapid, and the available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

Most areas of this soil are used as pasture; some are used as cropland. This soil is fairly well suited to use as pasture, but plant growth is limited by the low available water capacity and insufficient nutrients. The pasture provides fair grazing during spring and fall. Liming, fertilizing, weed control, and pasture rotation help

maintain a desirable plant community. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

This soil is poorly suited to corn, small grains, and forage grasses and legumes. The major management concerns are the low available water capacity and the low natural fertility. The hazard of drought is severe. Returning crop residue to the soil, applying manure, and proper fertilizing are effective in maintaining tilth and fertility. Early-maturing crops, such as small grains, make better use of spring soil moisture. Liming increases the effectiveness of fertilizer and improves legume stands.

The soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetative cover should be left to reduce soil blowing while young trees are becoming established. Competing vegetation, including weeds, can be controlled by cultivation or by herbicides.

This soil is fairly well suited to use as woodland. The main limitation is severe seedling mortality caused by droughtiness and by soil blowing. Droughtiness can be partly overcome by planting tree species that withstand drought. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and by maintaining vegetative cover on adjacent fields. Supplemental water is needed in droughty periods to help seedlings survive, especially in their first year. Replacement of some seedlings may be necessary.

This soil is well suited to use as building sites. Erosion can be a severe hazard during construction. Land shaping may be necessary in some areas. The soil is suited to roads. It readily absorbs the effluent from septic tanks but does not adequately filter it. Consequently, the ground water supply can become polluted. Septic tank absorption fields should have at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material placed on the surface.

This soil is in capability subclass IVs and in woodland suitability group 3s.

454C—Mahtomedi loamy coarse sand, 8 to 15 percent slopes. This is a rolling, excessively drained soil. It is on ground moraines and outwash plains on knolls that have concave side slopes. The areas vary in shape. They range in size from 4 to 50 acres.

Typically, the surface layer is black loamy coarse sand about 2 inches thick. The subsurface layer is very dark grayish brown coarse sand about 3 inches thick. The subsoil is dark brown coarse sand about 20 inches thick. The underlying material is brown, noncalcareous gravelly coarse sand to a depth of 60 inches or more. In some places there are subhorizons that are less than 10 percent or more than 35 percent coarse fragments. In some areas there is a discontinuous layer of finer textured material in the soil.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Chetek, Cushing, and DeMontreville soils. The Chetek soils formed in a loamy mantle over sandy or sandy-skeletal glacial outwash. The Cushing soils formed in loamy brown glacial till. The DeMontreville soils have a sandy mantle that is 20 to 40 inches thick. All of these soils and the Mahtomedi soil are in similar positions on the landscape.

Permeability is rapid, and the available water capacity is low. The content of organic matter and the level of natural fertility are low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

Most areas of this soil are used as pasture or woodland. The soil is fairly well suited to use as pasture, but plant growth is limited because of the low available water capacity and low natural fertility. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months. The soil generally is not suited to cultivated crops because of the low available water capacity and the low content of organic matter and because erosion is a hazard.

This soil is fairly well suited to trees and shrubs in windbreaks and in environmental plantings; however, only trees and shrubs that can tolerate droughty conditions should be selected. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Cultivation or herbicides help control competing vegetation, including weeds.

This soil is fairly well suited to use as woodland. Seedling mortality is severe because of droughtiness and soil blowing. Only trees that can tolerate droughty conditions should be selected for planting. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining a vegetative cover on adjacent fields. Supplemental watering is necessary in droughty periods during the first year of planting. Replacement of some seedlings may be necessary.

This soil is well suited to building site development. Erosion can be a severe hazard during construction, and land shaping may be necessary in some areas. Roads should be constructed on the contour, if possible, and roadbanks should be planted to well-adapted grasses to

minimize erosion. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. In a septic tank absorption field, there should be at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IVs and woodland suitability group 3s.

454E—Mahtomedi loamy coarse sand, 15 to 25 percent slopes. This is a hilly to steep, excessively drained soil on convex and concave side slopes of hills on ground moraines and outwash plains. The areas vary in shape and range from 4 to 25 acres in size.

Typically, the surface layer is black loamy coarse sand about 2 inches thick. The subsurface layer is very dark grayish brown coarse sand about 2 inches thick. The subsoil is dark brown coarse sand about 18 inches thick. The underlying material is stratified, brown, noncalcareous coarse sand to a depth of at least 60 inches. In some places, there are subhorizons that are less than 10 percent or more than 35 percent coarse fragments. In some areas, there is a discontinuous layer of finer textured material in the soil.

Included with this soil in mapping and making up 10 to 15 percent of the map unit are small areas of Cushing, DeMontreville, and Flak soils. Cushing and Flak soils formed entirely in noncalcareous glacial till. DeMontreville soils have a sandy mantle that is 20 to 40 inches thick. All of these soils are in positions on the landscape similar to those of the Mahtomedi soil.

Permeability is rapid. The available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is rapid. The potential for frost action is low. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture and woodland. It is poorly suited to use as pasture because of the low available water capacity and low natural fertility. Liming, fertilizing, weed control, and pasture rotation help maintain a desirable plant community. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

The soil generally is not suited to cultivated crops because erosion is a severe hazard and because of the low available water capacity, low content of organic matter, and low natural fertility.

The soil is fairly well suited to windbreaks and environmental plantings. Only those trees and shrubs that withstand droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Water erosion is a severe hazard unless the area is kept vegetated; site preparation should be restricted to the area within 2 feet of the plantings. Cultivation or herbicides can help control weeds and other competing vegetation.

The soil is fairly well suited to use as woodland. The main limitations are seedling mortality caused by droughtiness and the steep slopes, which aggravate the risk of erosion and limit the use of equipment. Droughtiness can be partly overcome by planting only those tree species that can withstand drought. Mulching and timely planting conserve moisture and reduce seedling mortality. Erosion can be controlled by mulching around the seedlings and by maintaining an adequate ground cover. Replacement of some seedlings may be necessary.

This soil is not well suited to use as building sites because of the slope. Erosion is a severe hazard. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil is poorly suited to septic tank absorption fields because of the steepness of the slope.

This soil is in capability subclass VIs and in woodland suitability group 3s.

454F—Mahtomedi loamy coarse sand, 25 to 40 percent slopes. This is a very steep, excessively drained soil. It is on summits, convex side slopes, and escarpments on ground moraines. The areas vary in shape and range from 3 to 20 acres in size.

Typically, the surface layer is black loamy coarse sand about 2 inches thick. The subsoil is dark brown coarse sand about 18 inches thick. The underlying material is stratified, brown, noncalcareous coarse sand to a depth of at least 60 inches. In some places, the subhorizons have less than 10 percent or more than 35 percent coarse fragments.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of Cushing and Flak soils. Cushing and Flak soils formed in noncalcareous glacial till and are in less sloping positions than the Mahtomedi soil.

Permeability is rapid, and the available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as woodland, although it is poorly suited to use as woodland. Seedling mortality is severe because of droughtiness. Erosion is a moderate hazard, and the very steep slopes limit the use of equipment. Only those trees that withstand droughty conditions should be selected for planting. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Erosion and soil blowing

can be controlled by mulching around the seedlings and maintaining a vegetative ground cover. Supplemental water is needed during droughty periods to reduce seedling mortality, especially in the first year after planting. Replacement of some seedlings may be necessary.

This soil is not suited to crops because of the steep slopes, droughtiness, the very low available water capacity, the low content of organic matter, and low natural fertility.

This soil is poorly suited to use as pasture. Droughtiness, severe erosion, and the very steep slope are major management concerns. Continuous cover and pasture rotation help maintain sufficient plant cover to control erosion, but plant mortality is high in a dry summer. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

This soil is fairly well suited to windbreaks and environmental plantings. Only trees and shrubs that can tolerate droughty conditions should be selected for planting. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Erosion is a severe hazard unless ground cover is maintained. Site preparation should be restricted to the area within 2 feet of the planting. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is not well suited to building site development because of slope. Erosion is a very severe hazard. Extensive land shaping generally is needed. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. The soil generally is not suited to septic tank absorption fields because of the steep slopes.

This soil is in capability subclass VIIs and in woodland suitability group 3s.

459—Corunna loam. This is a nearly level, poorly drained soil. It is on broad flats and in concave swales on water-worked ground and end moraines. This soil is subject to ponding. The areas of this soil vary in shape and range from 3 to 20 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray sandy loam about 11 inches thick. The subsoil is about 13 inches thick. It is olive gray, mottled sandy loam in the upper part and olive gray, mottled, calcareous loamy sand in the lower part. The underlying material is olive gray, mottled loam to a depth of at least 60 inches. In some places, the stratified layers are more than 40 inches thick. In some areas, there is more gravel in the subsoil.

Included with this soil in mapping and making up 5 to 10 percent of most mapped areas are small areas of Coriff soils in similar positions. Coriff soils are poorly drained and contain lime throughout.

The permeability of this soil is moderately slow. The available water capacity is high. The content of organic matter is moderately low, and natural fertility is high. Surface runoff is very slow or is ponded. The seasonal high water table is within 2 feet of the surface.

This soil is used mainly for crops. Wetness and ponding are the main management concerns. If the soil is artificially drained, it is well suited to corn, small grains, and forage grasses and legumes. Open ditches and subsurface drains can provide adequate drainage where there is a suitable outlet. Sandy material in the lower part of this soil can flow into tile drains and block them. In laying out a drainage system, where sandy material is encountered at the same depth as the tile line, blinding the tile with loamy soil material helps keep the tile open and functioning properly. Proper fertilization, applications of manure, and crop residue left on the surface improve fertility and tilth.

This soil is well suited to use as pasture, but artificial drainage is needed. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Proper fertilization, weed control, pasture rotation, timely deferment of grazing, and restricted use during wet periods help maintain a desirable plant community and produce high yields of forage.

This soil is well suited to windbreaks and environmental plantings. Only trees and shrubs that can tolerate excess moisture conditions should be selected for planting. Seedling mortality is moderate because of wetness, and spring planting can be delayed. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil generally is not suited to building site development or to septic tank absorption fields because of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads by ponding and frost action.

This soil is in capability subclass IIw.

461B—Koronis loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on crests and side slopes on uplands. The areas vary in shape and range from 3 to 70 acres in size.

Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is about 19 inches thick. It is dark yellowish brown sandy clay loam in the upper part and brown and dark brown loam in the lower part. The underlying material is light olive brown loam to a depth of 60 inches or more. In places, the subsoil is less developed and has weaker structure. Also, in some places the dark surface layer is thicker. In some areas the soil is moderately well drained.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of

Cordova, Hamel, and Marcellon soils. Cordova and Hamel soils are poorly drained. They are in drainageways and wet, concave swales. Marcellon soils are moderately well drained and are on flats and gentle convex slopes.

Permeability is moderate to moderately rapid, and the available water capacity is high. The content of organic matter is medium, and natural fertility is high. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as cropland. It is well suited to corn, small grains, and forage grasses and legumes. Controlling erosion and maintaining fertility are major management concerns. Minimum tillage, crop residue returned to the soil, and proper crop rotation are effective in controlling erosion. Grassed waterways commonly are needed to control gullying.

This soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help maintain desirable grasses for high yields of forage.

This soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation, cultivating the soil, and cutting, spraying, girdling, or prescribed burning control competing vegetation, including weeds.

This soil is well suited to building site development. Roads should be constructed on well compacted, coarse textured fill material to prevent damage to the roads caused by low strength and frost action. This soil is suitable for use as septic tank absorption fields.

This soil is in capability subclass IIe and in woodland suitability group 2o.

461C—Koronis loam, 6 to 12 percent slopes. This is a sloping, well drained soil on crests and convex side slopes on uplands. The areas vary in shape and range from 3 to 30 acres in size.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsoil is dark yellowish brown loam about 19 inches thick. The underlying material is light olive brown loam to a depth of 60 inches or more. In some places, the subsoil is less developed and has weaker structure. Also, in some areas the dark surface layer is thinner.

Included with this soil in mapping and making up 5 to 15 percent of the mapped areas are small areas of Cordova and Hamel soils. Cordova and Hamel soils are poorly drained and are in drainageways and wet, concave swales.

Permeability is moderate to moderately rapid, and the available water capacity is high. The content of organic matter is medium, and natural fertility is high. Surface runoff is medium to rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is fairly suited to corn, small grains, and forage grasses and legumes. Controlling erosion and maintaining fertility are the main concerns in management. Minimum tillage, crop residue returned to the soil, stripcropping, and proper crop rotation are effective in controlling erosion. In some places grassed waterways are needed to control gullying.

This soil is well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help maintain desirable grasses for high yields of forage. Overgrazing, however, causes the plant community to deteriorate, so that runoff increases and the quality of forage is impaired.

This soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation by cultivating the soil and by cutting, spraying, girdling, or prescribed burning controls competing vegetation, including weeds.

This soil is well suited to building site development. Erosion is a moderate hazard during construction. Land shaping may be necessary in some areas. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads caused by low strength and frost action. The roads should be constructed on the contour, if possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil is suited to septic tank absorption fields; however, land shaping and installing the distribution lines on the contour generally are necessary for the proper operation of a septic tank absorption field.

This soil is in capability subclass IIIe and in woodland suitability group 2o.

465—Kalmarville sandy loam, frequently flooded. This is a nearly level, poorly drained and very poorly drained soil on flood plains and concave bottom lands. The areas vary in shape and range from 10 to 200 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is about 32 inches thick. It is black, mottled sandy loam and loam and is stratified with layers of very dark gray, mottled loamy sand. It is calcareous in the lower part. The underlying material is dark grayish brown, mottled, calcareous coarse sand to a depth of at least 60 inches. In some areas, the surface layer contains more or less clay than is typical. Also, in some places there are layers of organic soil in the upper part of the soil.

Permeability is moderately rapid in the upper mantle and rapid in the underlying material. The available water

capacity is moderate. The content of organic matter is moderate, and natural fertility is high. Surface runoff is slow. The seasonal high water table is within 1 foot of the surface.

This soil is used mainly as pasture. It is fairly well suited to use as pasture. However, in some areas it is too often flooded or too overgrown with small willows and sedges to make suitable pasture.

This soil generally is not suited to cultivation because of frequent flooding. Only those trees and shrubs that can tolerate flooding and wetness should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because of wetness, and spring planting may be delayed. Untimely flooding can cause severe erosion and damage to seedlings unless the surface is adequately protected by close-growing cover. Site preparation should be restricted to an area within 2 feet of the planting. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil generally is not suited to building sites or septic tank absorption fields because of flooding. Constructing roads on raised, well compacted, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads caused by flooding, wetness, and frost action.

This soil is in capability subclass VIw.

511—Marcellon loam. This is a nearly level, somewhat poorly drained soil on ground moraines. It is on the concave lower part of side slopes and on slightly convex rises. The areas vary in shape and range from 3 to 50 acres in size. This soil is occasionally flooded.

Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is black and very dark gray loam about 9 inches thick. The subsoil is brown and dark brown, mottled sandy clay loam about 17 inches thick. The underlying material is light olive brown, mottled, calcareous sandy loam to a depth of at least 60 inches. In some places the subsoil is less developed and has weaker structure. Also, in some areas, the dark surface soil is less than 8 inches thick. In some areas the soil is poorly drained.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Glencoe soils, which are very poorly drained and are in depressions.

Permeability is moderate to moderately rapid, and the available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Minimum tillage, applying manure, and returning crop residue help to improve fertility and tilth and to conserve moisture.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help maintain a good stand of desirable grasses that produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is not suitable for building sites and septic tank absorption fields because of flooding and the seasonal high water table. Constructing roads on raised, well compacted, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads by flooding, wetness, and frost action.

This soil is in capability class I.

525—Muskego muck. This is a nearly level, very poorly drained soil in depressions and lake basins on uplands. The areas vary in shape and range in size from 10 to 40 acres. This soil is subject to ponding.

Typically, the upper organic layers are black muck about 31 inches thick. The underlying material is very dark gray and dark olive gray, calcareous limnic material, mainly coprogenous earth to a depth of at least 60 inches. In some places, the muck layers are mildly alkaline, or the percentage of partly decomposed organic material is higher.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Cathro and Markey soils. Cathro and Markey soils are on the edge of the areas of Muskego soil; they have mineral material at a depth of less than 51 inches.

Permeability is moderate to moderately rapid in the upper part of the soil and slow in the underlying sedimentary peat. The available water capacity is very high. The content of organic matter is very high, and natural fertility is low. Surface runoff is very slow or is ponded. The seasonal high water table is within 1 foot of the surface.

In most places this soil is in native vegetation and is used as wild hay pasture. It is well suited to use as habitat for wetland wildlife. Creating areas of open water for waterfowl improves the habitat. The native vegetation provides good cover and food for waterfowl, furbearers, and game animals.

The soil is poorly suited to corn, small grains, and forage grasses and legumes. Alfalfa commonly drowns out or is short-lived. Excess water, low fertility, and soil blowing are the main concerns in management. Wetness and ponding can be controlled by adequate artificial drainage. Where adequate outlets are available, open ditches remove excess water to permit earlier planting and minimize inundating of crops. Returning crop residue to the soil and plowing that leaves the surface rough and cloddy help minimize soil blowing.

The soil is poorly suited to use as pasture. Grazing when the soil is wet and overgrazing cause hummocks to form. Proper stocking rates, pasture rotation, fertilization, restricted use during wet periods, and improved drainage help establish and maintain grasses that produce high yields of forage.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe because of wetness and ponding. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is poorly suited to use as woodland. Growth rates typically are slow but can be improved by removing excess water. The use of equipment in planting and harvesting is limited by low strength and wetness. Competing vegetation must be controlled. Only those species that tolerate wetness should be planted.

This soil generally is not suitable for building sites or septic tank absorption fields because of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage resulting from ponding, frost action, and low soil strength.

This soil is in capability subclass IVw and in woodland suitability group 3w.

540—Seelyeville muck. This is a nearly level, very poorly drained soil in depressions on uplands. The areas vary in shape and range in size from 10 to 200 acres. This soil is subject to ponding.

Typically, the organic layers are very dark brown and black muck to a depth of at least 60 inches. In some places, the organic material is less than 51 inches thick. Also, in some areas, the soil is mildly alkaline throughout.

Permeability is moderately rapid to moderately slow. The available water capacity is very high. The content of organic matter is very high, and natural fertility is low. Surface runoff is very slow or is ponded. The water table is within 2 feet of the surface throughout the year.

In most areas this soil is in native vegetation and is used as wild hay pasture. It is well suited to use as habitat for wetland wildlife. Creating areas of open water improves the habitat, and wetland plants that provide cover for waterfowl, furbearers, and game animals grow well.

The soil is poorly suited to corn, small grains, and forage grasses and legumes. Excess water, low fertility, unseasonable frost, and soil blowing are the main concerns in management. Wetness and ponding can be controlled by open ditches where outlets are available. Removing excess water permits earlier planting and helps minimize ponding. Returning crop residue to the soil and plowing that leaves the surface rough and cloddy help prevent soil blowing. Under intensive management, such truck crops as cabbage, carrots, potatoes, and radishes can be grown successfully. Cultured sod can also be grown as a commercial crop.

The soil is poorly suited to use as pasture. Grazing when the soil is wet and overgrazing cause hummocks to form. Proper stocking rates, pasture rotation, fertilization, restricted use during wet periods, and improved drainage help establish and maintain grasses that produce high yields of forage.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe because of wetness and ponding. Weeds and other herbicides can be controlled by cultivation.

The soil is poorly suited to use as woodland. Growth rates typically are slow but can be improved by drainage. The use of equipment in planting and harvesting is limited by low strength and wetness. Other concerns are plant competition and seedling mortality. Competing vegetation must be controlled. Only species that tolerate wetness should be planted.

This soil is not suitable for building sites because of ponding and because the low soil strength can result in structural damage. The soil is also not suitable for septic tank absorption fields because of ponding. Constructing roads on raised, well compacted fill material and providing adequate side ditches and culverts help protect the roads from ponding and frost damage.

This soil is in capability subclass IVw and in woodland suitability group 4w.

541—Rifle mucky peat. This is a nearly level, very poorly drained soil in concave swales and depressions on outwash plains and ground moraines. The areas vary in shape and range from 30 to about 200 acres in size. This soil is subject to ponding.

Typically, the surface layer is black sapric material about 8 inches thick. The subsurface tier is very dark brown and dark brown hemic material about 24 inches thick. The underlying tier is very dark brown hemic material to a depth of at least 60 inches. In some areas there is loamy material at a depth of less than 51 inches.

Included with this soil in mapping and making up 2 to 10 percent of the map unit are small areas of Muskego and Seelyeville soils in similar positions on the landscape. Muskego soils have sapric material in the subsurface tier, and limnic material, mainly coprogenous earth, dominates the bottom tier. In Seelyeville soils the subsurface and bottom tiers are dominantly sapric material.

Permeability is moderate to moderately rapid, and the available water capacity is very high. The content of organic matter is very high, and natural fertility is low. Surface runoff is very slow or is ponded. The seasonal high water table is within 1 foot of the surface.

In most areas this soil is in native vegetation and is used as wild hay pasture. Without artificial drainage, it is

Fgure 9.—This field in an of Rifle mucky peat is being prepared for seeding with improved Kentucky bluegrass for cultured sod production.

well suited to development as habitat for wetland wildlife. Impoundments can be constructed to flood shallow excavated ponds for migratory waterfowl and elongated channels for furbearers.

This soil is poorly suited to corn, small grains, and forage grasses and legumes. The major management concerns are excess water, ponding, low fertility, and unseasonable frost. Corn is grown primarily for silage because early frost usually prevents corn from maturing as grain. Ponding is a concern during the spring thaw and in periods of heavy rain. The seasonal high water table can be lowered by adequate drainage. Soil blowing becomes a concern once the soil is cultivated, but it can be controlled by cover crops and field windbreaks. Returning crop residue to the soil and leaving plowed areas rough and cloddy also help minimize soil blowing. Under intensive management, such truck crops as potatoes, beets, carrots, onions, radishes, cabbage, and turnips can be grown successfully. Cultured sod can also be grown (fig. 9).

The soil is poorly suited to use as pasture because of wetness, ponding, and the spongy footing. Cattle tend to become mired and to sink into the wet ground. In many areas this soil is used for wild hay and meadow pasture.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe because of wetness and ponding. Competing plants, including weeds, can be controlled by cultivation or by herbicides.

The soil is poorly suited to use as woodland. Growth rates typically are slow but can be improved by drainage. The use of equipment in planting and harvesting is limited by low strength and wetness. Other concerns are plant competition and seedling mortality. Competing vegetation must be controlled. Only those species that tolerate wetness should be planted.

The soil generally is not suitable for building sites or septic tank absorption fields because of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads by ponding and frost action.

This soil is in capability subclass IVw and in woodland suitability group 5w.

543—Markey muck. This is a nearly level, very poorly drained soil in depressions on uplands. The areas vary in shape and range in size from 3 to 60 acres. This soil is subject to ponding.

Typically, the upper organic layers are black muck about 25 inches thick. The next layer is mottled, dark gray sandy loam about 6 inches thick. The underlying material is gray, mottled sandy loam and dark grayish brown, mottled gravelly coarse sand to a depth of at least 60 inches. In some places, a dark mineral layer underlies the organic surface layer. Also, in some areas there is a layer of coprogenous earth 16 to 40 inches thick.

Permeability is moderately rapid, and the available water capacity is very high. The content of organic matter is very high, and natural fertility is low. Surface runoff is very slow or is ponded. The seasonal high water table is within 1 foot of the surface.

This soil is mainly in native vegetation and is used as wild hay pasture. It is well suited to use as habitat for wetland wildlife. Creating areas of open water for waterfowl improves the habitat. The native vegetation provides plentiful food and cover for waterfowl, furbearers, and big and small game.

The soil is poorly suited to corn, small grains, and forage grasses and legumes. The major concerns in management are excess water, ponding, low fertility, and unseasonable frost. Corn is grown primarily for silage, because in most years early frost prevents corn from maturing as grain. Where suitable outlets are available, removing excess water by open ditches and subsurface drainage lines permits earlier planting and minimizes the inundating of crops. Soil blowing becomes a concern if the soil is cultivated, but it can be controlled by planting cover crops and field windbreaks. Returning crop residue to the soil and plowing that leaves the surface rough and cloddy also help minimize soil blowing.

The soil is poorly suited to use as pasture because of wetness, ponding, and the spongy footing. Grazing when the soil is wet and overgrazing cause hummocks to form. Proper stocking rates, pasture rotation, fertilization, restricted use during wet periods, and improved drainage help establish and maintain grasses that produce high yields of forage.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe because of wetness and ponding. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is poorly suited to use as woodland. Growth rates typically are slow but can be improved by removal of excess water. The use of equipment in planting and harvesting is limited by low strength and wetness. Other concerns are plant competition and seedling mortality. Competing vegetation must be controlled. Only those species that tolerate wetness should be planted.

This soil is not suitable for building sites or septic tank absorption fields because of the hazard of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding and frost action.

This soil is in capability subclass IVw and in woodland suitability group 5w.

544—Cathro muck. This is a nearly level, very poorly drained soil in depressions. The areas vary in shape and range in size from 5 to 60 acres. This soil is subject to ponding.

Typically, the upper organic layers are black muck about 40 inches thick. The underlying material is grayish brown, mottled silt loam in the upper part and olive gray, mottled loam in the lower part to a depth of at least 60 inches. In some places, the subsoil is thicker or thinner, and the depth to lime varies with the thickness of the subsoil. In some places, the muck layers are mildly alkaline. In some areas, a dark mineral layer underlies the organic surface layer.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Glencoe soils in similar positions. Glencoe soils formed entirely in mineral soil material.

Permeability is moderately slow to moderately rapid in the organic layers and moderate to moderately slow in the mineral underlying material. The available water capacity is very high. The content of organic matter is very high, and natural fertility is low. Surface runoff is very slow or is ponded. The seasonal high water table is within 1 foot of the surface.

This soil is mainly in native vegetation and is used as wild hay pasture. It is well suited to use as habitat for wetland wildlife. Creating areas of open water for waterfowl improves the habitat. The native vegetation provides plentiful food and cover for waterfowl, furbearers, and big and small game.

This soil is poorly suited to corn, small grains, and forage grasses and legumes. The major concerns in

management are excess water, ponding, low fertility, and unseasonable frost. Where suitable outlets are available, removing excess water by open ditches and subsurface drainage lines permits earlier planting and minimizes the inundating of crops. Soil blowing becomes a concern if this soil is cultivated, but it can be controlled by planting cover crops and field windbreaks. Returning crop residue to the soil and plowing that leaves the surface rough and cloddy also help minimize soil blowing.

The soil is poorly suited to use as pasture because of wetness, ponding, and the spongy footing. Grazing when the soil is wet and overgrazing cause hummocks to form. Proper stocking rates, pasture rotation, fertilization, restricted use during wet periods, and improved drainage help establish and maintain grasses that produce good yields of forage.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe because of wetness and ponding. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is poorly suited to use as woodland. Growth rates typically are slow but can be improved by removal of excess water. The use of equipment in planting and harvesting is limited by low strength and wetness. Other concerns are plant competition and seedling mortality. Competing vegetation must be controlled. Only those species that tolerate wetness should be planted.

This soil is not suitable for building sites or septic tank absorption fields because of the hazard of ponding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help protect the roads from damage caused by ponding and frost action.

This soil is in capability subclass IVw and in woodland suitability group 5w.

565—Eckvoll loamy sand. This is a nearly level, moderately well drained soil on ground and end moraines that have a sandy mantle. This soil is on flats and on the higher part of concave swales. The areas vary in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 9 inches thick. The subsurface layer is dark brown fine sand about 13 inches thick. The subsoil is mottled sandy clay loam and loam and is about 26 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The underlying material is light olive brown, mottled, calcareous loam. In some places, the sandy mantle is less than 20 inches thick; in other places, it is more than 40 inches thick. Also, in some areas the surface layer is thicker than is typical.

Included with this soil in mapping and making up 10 to 15 percent of the map unit are small areas of Cordova and Gonvick soils. The poorly drained Cordova soils are in concave swales and drainageways. The moderately well drained Gonvick soils do not have a sandy mantle and are in lower positions than the Eckvoll soil.

Permeability is moderately rapid in the upper part of the soil and moderate in the lower part. The available water capacity is moderate. The content of organic matter and natural fertility are low. Surface runoff is slow. The seasonal high water table is at a depth of 2 to 5 feet.

This soil is used mainly for crops, but some areas remain in mixed native hardwoods. This soil is fairly well suited to corn, small grains, and forage grasses and legumes. Conserving moisture, controlling erosion, and maintaining or improving fertility are the main concerns in management. Minimum tillage, returning crop residue to the soil, and proper crop rotation are effective in conserving moisture and controlling erosion. Irrigation can minimize the effects of drought.

The soil is well suited to use as pasture. Proper fertilizing is the most effective means of increasing forage production. Proper stocking rates, pasture rotation, and restricted use during wet periods help to maintain a desirable plant community and to produce high yields of forage.

The soil has fair suitability for windbreaks and environmental plantings. A wide variety of trees and shrubs can be used for windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is suited to use as woodland. Seedling mortality caused by droughtiness in the upper part of the soil, soil blowing, and plant competition are the main concerns in management. Droughtiness can be partly overcome by planting drought-resistant species. Shallow tillage, mulching, and timely planting conserve moisture and help reduce seedling mortality. Soil blowing can be controlled by mulching around the seedlings and maintaining an adequate plant cover on adjacent fields. Site preparation, cultivation, and spraying, cutting, girdling, or prescribed burning can control competing plants.

The soil is suited to building site development. Wetness is a concern. Buildings constructed on this soil should have the lower or basement level constructed above the seasonal high water table. Tile drains around the foundation help remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Constructing roads on well compacted, coarse textured base material helps prevent damage to the roads by frost action. The soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table.

This soil is in capability subclass IIIs and in woodland suitability group 2o.

566—Regal loam. This is a nearly level, poorly drained soil in swales, on broad flats, and on the rim of

depressions. The areas vary in shape and range from 5 to 200 acres in size.

Typically, the surface layer is black, calcareous loam about 6 inches thick. The next layers are black and very dark grayish brown, calcareous loam and are about 9 inches thick. The subsoil is dark grayish brown, mottled, calcareous sandy loam about 3 inches thick. The underlying material is grayish brown, mottled loamy coarse sand and light brownish gray, mottled, calcareous gravelly coarse sand to a depth of at least 60 inches. In some places the depth to sand and gravel is more than 20 inches. In some areas, there is less clay in the loamy mantle. Also, in some places there is an accumulation of lime in the surface layer.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Osakis soils. The moderately well drained Osakis soils are on convex rises.

Permeability is moderate in the upper part and rapid in the underlying material. The available water capacity is low. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. Under good management, it is fairly well suited to corn, small grains, and forage grasses and legumes. Wetness and maintenance of fertility and tilth are concerns in management. Open ditches and subsurface drains adequately remove excess water from this soil if suitable outlets are available. Returning crop residue to the soil and applying manure improve fertility and tilth and conserve moisture. Crop yields are improved by irrigation during periods of drought because of the low available water capacity. Without irrigation, this soil is better suited to shallow-rooting crops that mature early. Crops respond well to a balanced fertilization program.

This soil is well suited to use as pasture. Deferment of grazing during wet periods helps prevent soil compaction and improve tilth. Proper fertilization, weed control, and pasture rotation help maintain a desirable plant community and produce good yields of forage.

This soil is well suited to windbreaks and environmental plantings. Because the free carbonates in the soil tie up minerals and limit their availability, only trees and shrubs that can tolerate high lime conditions should be selected for planting. They should also be tolerant of wetness. Seedling mortality is moderate because of wetness. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without a basement. Land shaping should be designed to drain surface water away from the building foundation. Tile drains around the foundation help remove excess subsurface water. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to overcome wetness and prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that is placed on the surface.

This soil is in capability subclass IIIw.

571—Coriff loam. This is a nearly level, poorly drained, calcareous soil on broad flats and in concave swales on water-worked ground moraines. The areas vary in shape and range from 3 to 40 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark grayish brown loam and is also about 9 inches thick. The subsoil is 16 inches thick. The upper part is olive gray, mottled sandy loam, and the lower part is olive gray loamy sand. The underlying material is olive gray, mottled loam to a depth of at least 60 inches. In some places, there is no free lime above a depth of 20 inches. The depth to stratified layers is more than 40 inches in places. In some areas, there is more gravel in the subsoil than is typical. Also, in some areas there is a concentration of lime in the upper 16 inches of the soil.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Corunna and Roliss soils. These soils and the Coriff soil are in similar positions on the landscape. Roliss soils do not have stratified layers in the subsoil. Corunna soils are not calcareous throughout.

Permeability of this soil is moderate. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. With artificial drainage, it is well suited to corn, small grains, and forage grasses and legumes. Open ditches and subsurface tile drains can provide adequate drainage where there is a suitable outlet. In some areas, the lower part of this soil has layers of sand or fine sand, which can flow into tile lines and block them. Where sandy material is encountered at the same depth as the tile line, blinding the tile with suitable loamy material helps keep the drain open and functioning properly. Proper fertilization, applying manure, and returning crop residue to the soil improve fertility and tilth.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help to maintain a desirable plant community and to produce good yields of forage.

The soil is fairly well suited to windbreaks and environmental plantings. The free carbonates in this soil tie up minerals and make them largely unavailable to plants. Therefore, only those species that tolerate both a

limy soil and wetness should be selected for planting. Wetness causes moderate seedling mortality and can delay spring planting. Cultivation or herbicides can help control competing vegetation, including weeds.

This soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without a basement. Land shaping should be designed to drain surface water away from the building foundation. Tile drains around the foundation help remove excess subsurface water. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw.

572—Lowlein sandy loam. This is a nearly level to undulating, moderately well drained soil on broad flats and convex rises and knolls on water-worked ground moraines. The areas vary in shape and range from 3 to 40 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is about 17 inches thick. The upper part of the subsoil is dark brown sandy loam; the lower part is dark yellowish brown, mottled sand and light olive brown, mottled loamy sand. The underlying material is light olive brown, mottled, calcareous loam to a depth of at least 60 inches. In places, the mantle of stratified, water-worked material is more than 40 inches or less than 24 inches thick. Also, in some areas there is more gravel in the subsoil than is typical.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of the poorly drained Corunna soils. They are in concave swales and depressions.

Permeability is moderate. The available water capacity is moderate. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 3 to 5 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Management concerns are conserving moisture and maintaining fertility and tilth. Minimum tillage helps conserve moisture and reduce soil loss. A balanced fertilization program, applying manure, and returning crop residue to the soil improve fertility and tilth. This soil is somewhat droughty in short dry spells because the coarse textured subsoil has a limited available water capacity. Planting early-maturing crops or supplying the necessary moisture by irrigation can overcome this problem. Crops respond well to irrigation.

The soil is well suited to use as pasture. Proper fertilization, weed control, and proper stocking rates help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to building site development. Wetness is a concern. The lowest or basement level of buildings should be constructed above the seasonal high water table. Tile drains around the foundation help remove excess subsurface water. Land shaping should be designed to drain surface water away from a building. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads by frost action. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability class I.

582—Roliss loam. This is a nearly level, poorly drained, calcareous soil on broad flats and near the rim of depressions on ground moraines. The areas vary in shape and range from 5 to 80 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is olive gray, mottled loam about 8 inches thick. The underlying material is light olive gray and olive gray, mottled loam to a depth of at least 60 inches. In some places, there is a concentration of lime in the uppermost 16 inches of the soil. In other places, the surface layer and subsoil do not have free carbonates. In some areas the soil is very poorly drained.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Normania soils. Normania soils are moderately well drained; they are on small convex rises.

Permeability is moderately slow. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is very slow. The seasonal high water table is at a depth of 1 foot to 3 feet.

This soil is used mainly for crops. With proper management, it is well suited to corn, small grains, and forage grasses and legumes. Selecting suitable varieties is important because some kinds cannot tolerate prolonged wetness. Controlling wetness and maintaining fertility are concerns in management. Open ditches and subsurface drainage lines can adequately drain the excess water from this soil where suitable outlets are available. Applications of fertilizer and manure and the

return of crop residue to the soil maintain fertility and help offset the high content of lime.

The soil is well suited to use as pasture. Grazing when the soil is wet or overgrazing causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, fertilization, and restricted use during very wet periods help to maintain a stand of desirable grasses and to produce high yields of forage.

The soil has fair suitability for windbreaks and environmental plantings. Only those trees and shrubs that are tolerant of high lime conditions should be planted because the free carbonates in the soil tie up minerals and limit their availability. Species selected for planting should also be adapted to excess moisture conditions. Wetness causes moderate seedling mortality and can delay spring planting. Cultivation or herbicides help control competing vegetation, including weeds.

The soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without a basement, and land shaping should be designed to drain surface water away from the building foundation. Tile drains around the foundation help to remove excess subsurface water. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads caused by low strength and frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drainage is needed to keep the seasonal high water table at least 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIw.

591B—Doland silt loam, 1 to 6 percent slopes. This is a nearly level to undulating, well drained soil on silt-mantled ground and end moraines. The soil is on broad, convex crests and side slopes. The areas vary in shape and range from 3 to 60 acres in size.

Typically, the surface layer is black silt loam about 9 inches thick. The subsoil is very dark grayish brown and dark yellowish brown silt loam about 15 inches thick. The underlying material is olive brown and light olive brown, mottled, calcareous loam to a depth of at least 60 inches. In some places, the silty mantle is less than 18 inches thick; in other places, it is more than 30 inches thick. In some areas, the subsoil contains less clay. Also, in some places, the surface layer is more brownish in color where it is mixed with the subsoil by plowing. In some areas the dark surface layer is more than 16 inches thick.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Flom soils. The poorly drained Flom soils are in swales and drainageways.

Permeability is moderate, and the available water capacity is high. Surface runoff is medium. The content of organic matter and natural fertility are high. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Controlling erosion, maintaining fertility and tilth, and conserving moisture are the main concerns in management. Minimum tillage, grassed waterways, and proper crop rotation help conserve moisture and reduce soil loss. Some slopes are uniform and long enough to be farmed on the contour. A balanced fertilization program, applications of manure, and crop residue returned to the soil improve fertility and tilth. In areas where the subsoil contains less clay than is typical, droughtiness is a management concern.

This soil is well suited to use as pasture. Overgrazing reduces the protective cover and causes the plant community to deteriorate as undesirable nuisance species become established. Proper stocking rates, pasture rotation, fertilization, and weed control help to maintain the desirable grasses and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is well suited to building site development. Roads should be placed on well compacted, coarse textured base material to help prevent damage to the roads caused by low strength and frost action. This soil does not readily absorb the effluent in a septic tank absorption field because of its moderate permeability. A larger than average drain field helps overcome this limitation.

This soil is in capability subclass IIe.

597—Tara silt loam. This is a nearly level, moderately well drained soil on silt-mantled ground moraines. It is on toe slopes and low convex rises and in swales. The individual areas vary in shape and range from 3 to 30 acres in size.

Typically, the surface layer is black silt loam about 8 inches thick. The subsurface layer is black and very dark gray silt loam and is about 15 inches thick. The subsoil is about 12 inches thick. The upper part is dark grayish brown silt loam, and the lower part is olive brown silt loam. The underlying material is light olive brown, mottled, calcareous clay loam to a depth of at least 60 inches. In some places, the dark surface soil is less than 16 inches thick. In some areas, there is free lime in the surface layer and subsoil. Also, in some places, the subsoil has less clay than is typical. In some areas, the soil is well drained.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Flom soils. The poorly drained Flom soils are on wet flats and in shallow drainageways.

Permeability is moderate. The available water capacity is high. The content of organic matter and natural fertility are high. Surface runoff is slow. The seasonal high water table is at a depth of 3 to 5 feet.

This soil is used mainly for crops. It is well suited to corn, small grains, and forage grasses and legumes. Minimum tillage, applying manure, and returning crop residue to the soil help to improve fertility and tilth and to conserve moisture. Crops respond well to a balanced fertilization program.

The soil is well suited to use as pasture. Proper fertilization, weed control, and pasture rotation help maintain desirable grasses that produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

This soil is well suited to building site development. Seasonal wetness is a concern. Buildings on this soil should have the lower or basement level constructed above the seasonal high water table. Tile drains around the foundation help to remove excess subsurface water. Land shaping should be designed to drain surface water away from the building. Roads on this soil should be placed on well compacted, coarse textured fill material to help prevent damage to the roads by frost action. This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability class I.

611C—Hawick loamy sand, 6 to 12 percent slopes. This is a rolling, excessively drained soil on convex ridges, knolls, and side slopes on outwash plains and stream terraces. The areas vary in shape and range from 3 to 40 acres in size.

Typically, the surface layer is very dark brown loamy sand about 10 inches thick. The subsoil is dark yellowish brown loamy coarse sand and coarse sand. It is about 9 inches thick. The underlying material is dark yellowish brown and pale brown, calcareous gravelly coarse sand and coarse sand to a depth of at least 60 inches. In places, the surface layer has more gravel than is typical; in places, it is mildly alkaline. Also, in some places the underlying material is more than 35 percent gravel.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of the well drained Estherville soils on toe slopes or in concave swales.

Permeability is very rapid, and the available water capacity is low. The content of organic matter and the level of natural fertility are low. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture. The soil is poorly suited to cultivated crops because of the steepness of slopes. It is better suited to a permanent plant cover. Drought is a severe hazard on this soil. Erosion by wind and water is a moderate hazard where the plant cover is sparse.

This soil can be used as pasture, but its severe droughtiness limits the quality and quantity of the forage produced. Permanent pasture of warm-season grasses can produce adequate forage during summer. Overgrazing reduces the protective cover and causes the plant community to deteriorate as the less desirable species become established and eventually predominate. Weed control and proper stocking rates help maintain an adequate plant cover.

This soil has fair suitability for windbreaks and environmental plantings. Trees and shrubs that can withstand droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface while young trees are becoming established to protect them from injury by soil blowing. Controlling weeds and other competing vegetation by cultivation or by herbicides helps reduce plant competition for moisture.

This soil is suitable for building site development. Erosion is a severe hazard. Buildings should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Roads constructed on this soil should be placed on the contour wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. On septic tank absorption fields, there should be at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous, sandy material. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IVs.

611D—Hawick loamy sand, 12 to 40 percent slopes. This is a hilly to very steep, excessively drained soil on bluffs, valley walls, and ridges. The areas vary in shape and range from 3 to 10 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 10 inches thick. The subsoil is dark yellowish brown coarse sand about 8 inches thick. The underlying material is yellowish brown, calcareous coarse sand to a depth of at least 60 inches. In some places, the surface layer and subsoil are thinner than is typical. In a few places there is no subsoil.

Included with this soil in mapping and making up 3 to 5 percent of the map unit are small areas of the well drained Estherville soils on toe slopes.

Permeability is very rapid, and the available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is rapid. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly as pasture. It is poorly suited to use as pasture because drought is a severe hazard. Operating equipment is dangerous on the very steep slopes. The quality and quantity of forage are poor. Overgrazing reduces the protective cover and increases the hazard of erosion. Weed control and proper stocking rates help maintain an adequate plant cover. Permanent pasture of warm-season grasses produces more forage in summer than bluegrass, which is dormant during the hot months.

This soil is not suited to cultivated crops because of the steep slopes and the very low available water capacity. It is best kept in permanent plant cover.

This soil is poorly suited to windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Water erosion is a severe hazard unless the area is kept vegetated; site preparation should be limited to the area within 2 feet of the planting. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

Slope is a limitation to the use of this soil for building site development. Erosion is a severe hazard. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Roads should be constructed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. This soil is poorly suited to septic tank absorption fields because of the steep slopes.

This soil is in capability subclass VIs.

639A—Ridgeport sandy loam, 0 to 2 percent slopes. This is a nearly level, somewhat excessively drained soil in broad areas on outwash plains and in collapsed or pitted outwash areas along major streams. The areas vary in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is about 30 inches thick. The upper part is dark yellowish brown sandy loam and loam, and the lower part is yellowish brown sand. The underlying material is light yellowish brown sand to a depth of at least 60 inches. In some areas the surface layer and subsoil have more clay. Also, in some places, there is less clay in the subsoil.

Included with this soil in mapping and making up 2 to 10 percent of the map unit are small areas of Biscay, Estherville, and Litchfield soils. The poorly drained Biscay soils are in depressions and wet drainageways. The somewhat excessively drained Estherville soils are on small rises and side slopes where calcareous sand and gravel are near the surface. The moderately well drained Litchfield soils have distinct textural bands and are in lower lying areas.

Permeability of this Ridgeport soil is moderately rapid. The available water capacity is moderate. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

In most areas this soil is used for crops. It is fairly well suited to corn, small grains, and forage grasses and legumes. Controlling erosion, conserving moisture, maintaining fertility, and maintaining the moisture content by timely irrigation are management concerns. Minimum tillage or a winter cover crop helps to conserve moisture and to prevent soil blowing. If this soil is not irrigated, it is better suited to small grains that mature early. Crop residue left on the soil and applications of manure improve fertility and tilth and conserve moisture. Crops respond well to a balanced fertilization program. Applications of lime increase the effectiveness of fertilizers and improve legume stands.

This soil is well suited to use as pasture. Drought is the main management concern. Overgrazing the pasture reduces the protective cover and causes the plant community to deteriorate as undesirable nuisance species become established. Pasture rotation, proper fertilization, liming, weed control, and proper stocking rates help maintain a desirable plant community.

This soil is well suited to windbreaks and environmental plantings. Only trees and shrubs that can tolerate droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Water erosion is severe unless there is an adequate plant cover. Site preparation should be limited to the area within 2 feet of the planting. Some ground cover should be left on the surface to reduce soil blowing while young trees are becoming established. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is well suited to building sites and local roads. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. On septic tank absorption fields, there should be at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field

is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIs.

639B—Ridgeport sandy loam, 2 to 6 percent slopes. This is a gently sloping, somewhat excessively drained soil. It is on crests and convex side slopes on outwash plains and in collapsed or pitted outwash areas along major streams. The areas vary in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is about 18 inches thick. The upper part is dark yellowish brown sandy loam, and the lower part is yellowish brown loam. The underlying material is light yellowish brown coarse sand to a depth of at least 60 inches. In some areas, the subsoil does not have an accumulation of clay.

Included with this soil in mapping and making up 2 to 10 percent of the map unit are small areas of Biscay, Estherville, Fairhaven, and Litchfield soils. The poorly drained Biscay soils are in depressions and wet drainageways. The well drained Fairhaven soils have a loamy mantle 20 to 40 inches thick over sand and gravel and do not have an accumulation of clay in the subsoil. They are in lower lying parts of the mapped areas. The somewhat excessively drained Estherville soils are on small rises and side slopes where calcareous sand and gravel are near the surface. The moderately well drained Litchfield soils have distinct bands of varying texture and are lower lying than the Ridgeport soil.

Permeability is moderately rapid, and the available water capacity is moderate. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow. The seasonal high water table is at a depth of more than 6 feet.

In most areas this soil is used for crops. This soil is fairly well suited to corn, small grains, and forage grasses and legumes. Erosion and the low available water capacity are the major management concerns. Under irrigation, this soil is one of the most productive soils in the county. Without irrigation it is better suited to small grains that mature early. Minimum tillage, crop residue returned to the soil, and applications of manure improve fertility and tilth, conserve moisture, and reduce erosion. Crops respond to a balanced fertilization program. Applications of lime increase the effectiveness of fertilizers and improve legume stands.

This soil is fairly well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

This soil is fairly well suited to windbreaks and environmental plantings. Only trees and shrubs that can withstand droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Water erosion is severe unless the area is kept vegetated. Site preparation should be limited to an area within 2 feet of the planting. Some ground cover should be left on the surface to reduce soil blowing while young trees are becoming established. Cultivation or herbicides help remove competing vegetation, including weeds.

This soil is well suited to building sites and local roads. This soil readily absorbs but does not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. Septic tank absorption fields should be laid out only where there is at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous layer. In some places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IIIe.

804D—Koronis-Estherville complex, 12 to 25 percent slopes. This map unit consists of moderately steep and steep soils on hills and hillsides. The areas vary in shape and range from 3 to 30 acres in size.

The well drained Koronis soil makes up about 70 percent of the map unit, and the somewhat excessively drained Estherville soil about 20 percent. The individual areas of Koronis and Estherville soils are so small or so intricately mixed that it was not practical to separate them in mapping.

Typically, the Koronis soil has a very dark brown loam surface layer about 7 inches thick. The subsoil is dark yellowish brown loam about 15 inches thick. The underlying material, to a depth of 60 inches or more, is light olive brown loam that has an accumulation of lime in the upper part. In some places, the surface layer is sandy loam or loamy sand. Also, in some areas, the surface layer has been mixed with the subsoil by plowing and is very dark grayish brown or dark brown.

Typically, the Estherville soil has a very dark brown sandy loam surface layer about 7 inches thick. The subsoil is dark yellowish brown sandy loam about 12 inches thick. The underlying material is yellowish brown and light yellowish brown gravelly coarse sand to a depth of 60 inches or more. In some areas, the underlying material is loam or is stratified with layers of sandy loam, silt loam, or loamy sand; in some places this stratification begins in the subsoil.

Included in mapping and making up about 10 percent of the map unit are small, randomly scattered areas of Hawick soils, which are excessively drained.

Permeability is moderate to moderately rapid in the Koronis soil. In the Estherville soil, permeability is moderately rapid in the upper part and rapid in the underlying material. The available water capacity is high in the Koronis soil and low in the Estherville soil. The content of organic matter and natural fertility are high in

the Koronis soil. In the Estherville soil, the content of organic matter is moderate, and natural fertility is low. Surface runoff is rapid on the Koronis soil and medium on the Estherville soil. The seasonal high water table in both soils is below a depth of 6 feet.

In most areas, the soils are used as pasture. Pasture rotation and weed control help to maintain a stand of desirable pasture plants and to produce fair yields of forage. Overgrazing and pasturing during dry periods can destroy the plant cover, exposing the soils to erosion by wind and water.

In some areas the soils are farmed. The soils are not suited to crops because of the hazard of drought and the steep slopes. Crop growth is variable and uneven because of the contrasting loamy and sandy soils in this map unit. The less sloping soils in a few small areas are used for cultivated crops. Hay and pasture are the main crops. Oats are grown only to reestablish permanent hay or pasture.

The soils are poorly suited to windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some plant cover should be left on the surface to reduce soil blowing while young trees are becoming established. Water erosion is a severe hazard unless the area is kept vegetated; site preparation should be limited to the area within 2 feet of the planting. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

Slope is the main limitation to use of the soils for building site development. Erosion is a severe hazard. Extensive land shaping generally is necessary. Buildings should be designed to conform to the natural slope. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. The soils are poorly suited to septic tank absorption fields because of the steep slopes.

This map unit is in capability subclass VIe.

807D—Koronis-Sunburg complex, 12 to 25 percent slopes. This map unit consists of well drained soils in hilly to steep areas on ground and end moraines. The areas vary in shape and range from 3 to 70 acres in size.

Koronis soil makes up about 65 percent of the map unit, and Sunburg soil about 30 percent. The Koronis soil is on side slopes and lower convex rises. The Sunburg soil is on steeper, more convex knobs and summits. The individual areas of Koronis and Sunburg soils are so small or so intricately mixed that it was not practical to separate them in mapping.

Typically, the Koronis soil has a very dark grayish brown loam surface layer about 8 inches thick. The subsoil is about 18 inches thick. The upper part is brown and dark brown sandy clay loam, and the lower part is dark yellowish brown fine sandy loam. The underlying material is yellowish brown, calcareous fine sandy loam to a depth of at least 60 inches. In some places, the surface layer is mixed with the subsoil by plowing. Also, in some areas the underlying material contains more clay.

Typically, the Sunburg soil has a very dark grayish brown, calcareous loam surface layer about 9 inches thick. The underlying material to a depth of at least 60 inches is yellowish brown, calcareous fine sandy loam that has an accumulation of lime in the upper part. In some places, the surface layer is lighter in color. Also, in some areas the underlying material contains more clay.

Included with these soils in mapping and making up about 5 percent of the mapped areas are small areas of Hamel soils on toe slopes and in concave swales. Hamel soils are poorly drained.

Permeability is moderate to moderately rapid in Koronis soil and moderately rapid in Sunburg soil. The available water capacity is high in Koronis soil and moderate in Sunburg soil. Surface runoff is medium on both soils. The content of organic matter is medium and natural fertility is high in Koronis soil. The content of organic matter and the natural fertility are low in Sunburg soil. The seasonal high water table is at a depth of more than 6 feet.

In most areas, the soils are farmed or remain in mixed deciduous hardwoods and are used as wooded pasture. The soils are poorly suited to corn, small grains, and hay. The main concerns in management are controlling erosion and maintaining fertility and tilth. Minimum tillage, stripcropping, and proper crop rotation are effective in controlling erosion. Grassed waterways commonly are needed to control gullying. A balanced fertilization program, applying manure, and returning crop residue to the soil help improve fertility and tilth. Crops on Koronis soil respond better to applications of fertilizer than crops on Sunburg soil because the Sunburg soil has a high content of lime at or near the surface and its available water capacity is moderate.

The soils are well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help maintain a desirable plant community and an adequate yield of forage. Overgrazing should be prevented because it causes soil compaction and increased runoff and lowers the quality of forage.

The soils are well suited to windbreaks and environmental plantings. However, only trees and shrubs that are tolerant of high lime conditions should be selected for planting because the free carbonates in the soil tie up minerals and limit their availability to plants. Water erosion is severe unless the surface is protected by an adequate ground cover. Site preparation should be limited to the area within 2 feet of the plantings. Cultivation or herbicides can help control competing vegetation, including weeds.

Slope is the main limitation to the use of the soils for building site development. Erosion is a severe hazard. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. The soils are poorly suited to septic tank absorption fields because of the slope.

The soils are in capability subclass IVe.

848—Urban land-Osakis complex. This map unit is on nearly level outwash plains and valley trains. It consists mainly of urban developments; Osakis soil, which is moderately well drained, is the primary soil in undisturbed areas. The individual areas vary in shape and range from 15 to 150 acres in size. About 85 percent of this map unit is Urban land, and about 10 percent is Osakis soil. The areas of Urban land and of Osakis soil are so intricately mixed or so small that it was not practical to map them separately.

The Urban land in this map unit consists mainly of residential areas. Some small shopping centers and industrial plants and the accompanying parking lots are also included. In some places the surface soil and subsoil have been removed and the underlying material is exposed. Other areas have been covered with fill of varying depth.

Typically, the Osakis soil has a black loam surface layer about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 3 inches thick. The subsoil is dark yellowish brown and is about 12 inches thick. The upper part is sandy loam, and the lower part is mottled loamy coarse sand. The underlying material to a depth of at least 60 inches is mottled, grayish brown coarse sand and light olive brown, mottled gravelly coarse sand.

Included in mapping and making up about 5 percent of the mapped areas are a few small areas of Biscay, Dassel, Estherville, and Darfur soils. Biscay, Dassel, and Darfur soils are in small depressions and drainageways; they are poorly drained and very poorly drained. Estherville soils are on small knolls and side slopes around depressions and drainageways; they are somewhat excessively drained.

Permeability of the Osakis soil is moderate to moderately rapid in the upper part and rapid in the lower part. The available water capacity is low. The content of organic matter is moderate, and natural fertility is medium. Surface runoff is slow. Most areas of this map unit are artificially drained by sewer systems, gutters, and drainage tiles and, to a lesser extent, by surface and roadside ditches. The seasonal high water table is at a depth of 4 to 6 feet.

The Osakis soil is well suited to use as lawns, gardens, and playgrounds. It is also suited to building site development where drainage has been provided. In shallow excavations, as for basements, there is a hazard of sidewalls caving. Roads, streets, sidewalks, and driveways heave and crack because of frost action unless adequate drainage is provided and a suitable subbase material is used.

This map unit was not assigned to a capability subclass.

850—Urban land-Dassel complex. This map unit is on level outwash plains and valley trains. It consists mainly of urban developments; Dassel soil, which is poorly drained and very poorly drained, is the primary soil in undisturbed areas. The individual areas vary in shape and range from 10 to 200 acres in size. About 85 percent of this map unit is Urban land, and about 10 percent is Dassel soil. The areas of Urban land and of Dassel soil are so intricately mixed on the landscape or so small that it was not practical to map them separately.

The Urban land in this map unit consists mainly of residential areas. Some small shopping centers, warehouses, industrial plants, and the accompanying parking lots are also included. In some places the surface soil and subsoil have been removed and replaced with sandy fill. Other areas have been covered with fill of varying depth.

Typically, the Dassel soil has a black sandy loam surface layer about 11 inches thick. The subsurface layer is very dark gray sandy loam about 6 inches thick. The subsoil is olive gray and grayish brown sandy loam about 17 inches thick. The underlying material to a depth of at least 60 inches is stratified, olive brown loamy sand and coarse sand and has bands of finer textured material. In some areas, the finer textured bands are not present.

Included in mapping and making up about 5 percent of the mapped areas are a few small areas of Litchfield soils. The Litchfield soils are in nearly level, somewhat higher positions on the same landscape. They are moderately well drained.

Permeability of the Dassel soil is moderately rapid. The available water capacity is moderate. The content of organic matter is high, and natural fertility is medium. Surface runoff is slow. Most areas of this map unit are artificially drained by sewer systems, gutters, and drainage tiles and, to a lesser extent, by surface and roadside ditches. The seasonal high water table is within 1 foot of the surface in undrained areas.

The Dassel soil is well suited to use as lawns, gardens, playgrounds, and building sites. In the built-up areas, adequate artificial drainage generally has been provided to remove surface water and to control the seasonal high water table. Banks of shallow excavations have a tendency to cave.

This map unit was not assigned to a capability subclass.

865B—Urban land-Hubbard complex, 1 to 8 percent slopes. This map unit is on nearly level to

sloping crests on outwash plains and valley trains. It consists mainly of urban developments; Hubbard soil, which is excessively drained, is the primary soil in undisturbed areas. The individual areas vary in shape and range from 50 to 500 acres in size. About 85 percent of this map unit is Urban land, and about 10 percent is Hubbard soil. The areas of Urban land and of Hubbard soil are so intricately mixed on the landscape or so small that it was not practical to map them separately.

The Urban land in this map unit consists mainly of residential areas. Some shopping centers with office and commercial buildings, warehouses, industrial plants, schools, churches, and adjoining parking lots are also included. In some places the surface layer and subsoil have been removed and the underlying material is exposed. Other areas have been covered with fill of varying depth.

Typically, the Hubbard soil has a black loamy sand surface layer about 7 inches thick. The subsurface layer is very dark grayish brown loamy coarse sand about 7 inches thick. The subsoil is about 34 inches thick. The upper part is dark brown and brown coarse sand, and the lower part is yellowish brown coarse sand. The underlying material is yellowish brown coarse sand in the upper part and light yellowish brown, noncalcareous coarse sand in the lower part to a depth of at least 60 inches.

Included in mapping and making up about 5 percent of the mapped areas are a few small areas of Dickman, Duelm, and Estherville soils. Dickman and Estherville soils are in level glacial meltwater channels. They are well drained. Duelm soils are in shallow depressions and drainageways. They are somewhat poorly drained and moderately well drained.

Permeability of the Hubbard soil is rapid, and the available water capacity is low. The content of organic matter and natural fertility are low. Surface runoff is slow to medium. Most areas of this map unit are artificially drained by sewer systems and gutters that remove surface runoff. The seasonal high water table is at a depth of more than 6 feet.

The Hubbard soil is fairly well suited to lawns, gardens, and playgrounds. It is well suited to building site development. Wind erosion generally is a problem if this soil is left bare and exposed for an extended period. Banks of shallow excavations have a tendency to cave.

This map unit was not assigned to a capability subclass.

873—Prebish-Nokay complex. This map unit consists of level to nearly level Prebish and Nokay soils in slightly concave depressions, potholes, and drainageways on glacial moraines. The areas vary in shape and range from 4 to 40 acres in size. This map unit is about 45 percent Prebish soil and 35 percent Nokay soil.

Prebish soil is in the concave center of depressions; it is very poorly drained and is subject to ponding. Nokay soil is on narrow edges, small rises, and the upper parts of drainageways, and it is somewhat poorly drained. The minor soils are interspersed between the Prebish and Nokay soils and vary in drainage. The areas of the major soils are so intricately mixed or so small that it was not practical to separate them in mapping.

Typically, the Prebish soil has a surface layer of black loam about 18 inches thick. The subsurface layer is very dark gray sandy loam about 8 inches thick. The subsoil is gray and grayish brown, mottled sandy loam about 25 inches thick. The underlying material is dark brown, mottled sandy loam to a depth of at least 60 inches. In some places there is an organic surface layer as much as 6 inches thick.

Typically, the Nokay soil has a surface layer of very dark grayish brown fine sandy loam about 4 inches thick. The subsurface layer is dark grayish brown, mottled sandy loam about 11 inches thick. The subsoil is 33 inches thick. The upper part is brown, mottled loam, and the lower part is dark brown, mottled sandy loam. The underlying material is mottled sandy loam to a depth of at least 60 inches. In some areas the surface layer is silty.

Included with these soils in mapping and making up about 20 percent of the mapped areas are small areas of Alstad and Cathro soils. Cathro soils are very poorly drained; they have organic material 6 to 51 inches thick that is underlain by loamy material, and they are in depressions. Alstad soils are moderately well drained; they are on higher lying flats and in undulating areas.

Permeability is moderately slow in both soils. The available water capacity is moderate. The content of organic matter is moderate in Nokay soil and high in Prebish soil. Natural fertility is medium in both soils. Surface runoff is very slow or is ponded on the Prebish soil; it is slow on the Nokay soil. The seasonal high water table is at a depth of 1 foot to 3 feet in the Nokay soil. The water table is within 1 foot of the surface in the Prebish soil throughout the year.

These soils are mainly in native vegetation and wild hay pasture. In some areas they have been developed for use as cropland. They are fairly well suited to use as pasture. Deferment of grazing when the soil is wet helps prevent soil compaction and impaired tilth. Proper fertilization, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soils are poorly suited to corn, small grains, and forage grasses and legumes. The seasonal high water table and ponding are limitations that can be overcome by adequate artificial drainage. If the Prebish soil is worked when it is wet, it becomes cloddy and hard upon drying. Returning crop residue and applying manure to the soil help to maintain tilth.

The soils have fair suitability for windbreaks and environmental plantings. Only trees and shrubs that tolerate wet soil conditions should be selected for planting because wetness causes severe seedling mortality on the Prebish soil. Cultivation or herbicides can help control competing vegetation.

The soils are well suited to development as habitat for wetland wildlife. Impoundments can be constructed to flood shallow excavated ponds for migratory waterfowl and elongated channels for furbearers.

The soils generally are not suitable for building sites or septic tank absorption fields because of wetness and because ponding is a hazard on the Prebish soil. If roads are constructed across these soils, they should be placed on raised, coarse textured fill material, and adequate side ditches and culverts should be provided to help prevent damage to the roads by ponding and frost action.

These soils are in capability subclass IVw.

875B—Estherville-Hawick complex, 2 to 6 percent slopes. This map unit consists of somewhat excessively drained Estherville soil and excessively drained Hawick soil. The areas vary in shape and range from 10 to 200 acres in size.

Estherville soil makes up about 55 percent of the map unit, and Hawick soil makes up about 35 percent. The soils are gently undulating. Estherville soil is in lower lying positions on toe slopes and in swales and on long, smooth side slopes. Hawick soil is on more sloping, convex knolls and ridges. The individual areas of the soils are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Estherville soil has a black sandy loam surface layer about 7 inches thick. The subsoil is dark yellowish brown and is about 12 inches thick. The upper part is sandy loam or loam, and the lower part is loamy coarse sand. The underlying material is yellowish brown, calcareous gravelly coarse sand to a depth of at least 60 inches. In some places, sandy material is at a depth of less than 15 inches. Also, in places the surface layer has been mixed with the brownish subsoil by plowing.

Typically, the Hawick soil has a very dark brown loamy sand surface layer about 8 inches thick. The underlying material to a depth of about 22 inches is dark brown and dark yellowish brown, calcareous gravelly coarse sand; below that, it is yellowish brown, calcareous coarse sand to a depth of at least 60 inches. In some places, there is more gravel in the underlying material. Also, in some areas the surface layer is lighter in color.

Included in mapping and making up about 10 percent of the mapped areas are small areas of Biscay, Osakis, and Fairhaven soils. Biscay soils are poorly drained; they are in deeply set swales and depressions. Osakis soils are moderately well drained; they are on lower lying flats. Fairhaven soils are well drained; they are on toe slopes and in concave swales and drainageways.

Permeability is moderately rapid in the upper part of Estherville soil and rapid in the underlying material. Permeability is very rapid in Hawick soil. The available water capacity is low in both soils. The content of organic matter is moderate in Estherville soil and low in Hawick soil. Natural fertility is low in both soils. Surface runoff is slow to medium on Estherville soil and slow on Hawick soil. The seasonal high water table is at a depth of more than 6 feet.

In most areas the soils are farmed. They are poorly suited to corn, small grains, forage grasses, and legumes because of droughtiness. Shallow-rooting crops that mature early in the growing season before the hot, dry weather arrives do best. Management practices are mainly those that help to overcome droughtiness and to maintain fertility. Minimum tillage or a winter cover crop help to conserve moisture and to prevent soil blowing. A balanced fertilization program, applying manure, and returning crop residue help improve fertility. Irrigation can minimize the effects of drought. Crops on the Estherville soil respond better to irrigation because its available water capacity is not quite so low as that of the Hawick soil. Under irrigation, the Estherville soil is especially well suited to truck crops. Center pivot and traveling gun irrigation systems are those most commonly used.

The soils are fairly well suited to use as pasture. The main management concern is the hazard of drought. Overgrazing the pasture reduces the protective cover and causes the plant community to deteriorate as the less desirable species increase. Pasture rotation, proper fertilization, weed control, and proper stocking rates help to maintain a desirable plant community and to produce high yields of forage. Permanent pasture of warm-season grasses produces forage during the hot summer months when bluegrass is dormant.

The soils have fair suitability for windbreaks and environmental plantings. Trees and shrubs that can withstand droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. While young trees are becoming established, some vegetation should be left on the surface to protect them from injury by soil blowing. Cultivation or herbicides help control competing vegetation, including weeds.

The soils are well suited to building site development. Erosion is a hazard. The soils readily absorb but do not adequately filter the effluent from septic tanks. Consequently, the ground water supply can become polluted. On septic tank absorption fields, there should be at least 6 inches of sandy loam or loam between the distribution lines and the underlying porous, sandy material. In some places a mound system can be installed: the septic tank absorption field is laid out in

suitable loamy material that has been placed on the surface.

These soils are in capability subclass IVs.

954C—Ves-Storden loams, 6 to 12 percent slopes. These are sloping, well drained soils on ground and end moraines. The areas vary in shape and range from 3 to 25 acres in size.

Ves soil makes up about 70 percent of the map unit, and Storden soil makes up about 25 percent. Ves soil is on side slopes and lower convex rises. Storden soil is on steeper, more convex knobs, knolls, and ridges. The individual areas of the soils are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Ves soil has a very dark gray loam surface layer about 9 inches thick. The subsoil is dark yellowish brown loam about 15 inches thick. The underlying material to a depth of at least 60 inches is light olive brown loam that has an accumulation of lime in the upper part. In some places, the surface layer is thinner than is typical, or it is mixed with the subsoil by plowing. In some areas there is no accumulation of lime in the upper part of the underlying material.

Typically, the Storden soil has a dark grayish brown, calcareous loam surface layer about 9 inches thick. The underlying material to a depth of at least 60 inches is yellowish brown and light olive brown, mottled, calcareous loam that has an accumulation of lime in the upper part. In some places, the subsoil is brown, calcareous loam. Also, in some places, the surface layer is darker in color.

Included with these soils in mapping and making up about 5 percent of the mapped areas are small areas of Normania soils, which are moderately well drained, on toe slopes and in concave swales.

Permeability is moderate in both soils, and the available water capacity is high. The content of organic matter is high in Ves soil and low in Storden soil. Natural fertility is high in Ves soil and low in Storden soil. Surface runoff is medium on Ves soil and rapid on Storden soil. The seasonal high water table is at a depth of more than 6 feet.

In most areas these soils are farmed. They are fairly well suited to corn, small grains, and forage grasses and legumes. The main concerns in management are controlling erosion and maintaining fertility and tilth. Conservation tillage, stripcropping, and proper crop rotation are effective in controlling erosion. Grassed waterways are needed in some places to control gullying. A balanced fertilization program, applying manure, and returning crop residue to the soil help improve fertility and tilth. Crops on Storden soil respond less strongly to applications of fertilizers than crops on Ves soil, because Storden soil has a high content of lime near the surface.

The soils are well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help to maintain a desirable plant community and to produce high yields of forage. Overgrazing causes soil compaction, increases runoff, and reduces the quality of forage.

The soils are well suited to windbreaks and environmental plantings. However, only trees and shrubs that are tolerant of high lime conditions should be selected for planting because the free carbonates, particularly in the Storden soil, tie up minerals and limit their availability to plants. Water erosion is severe unless the surface is protected by an adequate ground cover. Site preparation should be limited to the area within 2 feet of the plantings. Cultivation or herbicides can help control competing vegetation, including weeds.

The soils are well suited to building site development. However, erosion is a hazard. Buildings should be designed to conform to the natural slope. Land shaping is needed in some areas. If roads are constructed on these soils, they should be placed on well compacted, coarse textured base material to help prevent damage by low strength and frost action. Roads should be constructed on the contour, wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. The soils are suitable for septic tank absorption fields. Land shaping and installing the distribution lines on the contour generally are necessary for the proper operation of the absorption field.

These soils are in capability subclass IIIe.

954D—Ves-Storden loams, 12 to 18 percent slopes. These are moderately steep, well drained soils on ground and end moraines. The areas vary in shape and range from 3 to 15 acres in size.

Ves soil makes up about 60 percent of the map unit, and Storden soil makes up about 40 percent. Ves soil is on side slopes and lower summits. Storden soil is on the steeper, more convex hills, hillsides, and ridges. The individual areas of the soils are so small or so intricately mixed that it was not practical to map them separately.

Typically, the Ves soil has a very dark grayish brown loam surface layer about 8 inches thick. The subsoil is dark yellowish brown loam about 14 inches thick. The underlying material to a depth of at least 60 inches is light olive brown, calcareous loam that has an accumulation of lime in the upper part. In some places, the surface layer is thinner than is typical, or it is mixed with the subsoil by plowing. In some areas there is no accumulation of lime in the upper part of the soil.

Typically, the Storden soil has a dark grayish brown, calcareous loam surface layer about 6 inches thick. The underlying material to a depth of at least 60 inches is yellowish brown and light olive brown, mottled, calcareous loam that has an accumulation of lime in the upper part. In some places, the subsoil is brown. Also, in some places, the surface layer is darker.

Permeability is moderate in both soils. The available water capacity is high. The content of organic matter is

moderate in Ves soil and low in Storden soil. Natural fertility is medium in Ves soil and low in Storden soil. Surface runoff is rapid on both soils. The seasonal high water table is at a depth of more than 6 feet.

In most areas the soils are farmed or are in pasture. They are poorly suited to corn, small grains, and forage grasses and legumes because of the hazard of erosion. Management concerns are controlling erosion and maintaining fertility and tilth. Proper crop rotation that favors cover crops such as alfalfa, minimum tillage, and stripcropping are effective in controlling erosion. Grassed waterways are needed in some places to control gullying. A balanced fertilization program, applying manure, and returning crop residue to the soil help improve fertility and tilth. Crops on Storden soil respond less strongly to applications of fertilizers than crops on Ves soil because Storden soil has a high content of lime.

The soils are well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help to maintain a desirable plant community and to produce high yields of forage. Overgrazing causes soil compaction, increases runoff, and impairs the quality of forage.

The soils are well suited to windbreaks and environmental plantings. However, only trees and shrubs that are tolerant of high lime conditions should be selected for planting because the free carbonates, particularly in the Storden soil, tie up minerals and limit their availability to plants. Water erosion is severe unless the surface is protected by an adequate ground cover. Site preparation should be limited to the area within 2 feet of the plantings. Cultivation or herbicides can help control competing vegetation, including weeds.

Slope is a limitation to the use of the soils for building site development. Erosion can be a severe hazard. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Roads on these soils should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. The soils are poorly suited to septic tank absorption fields because of the moderately steep slopes. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of an absorption field.

These soils are in capability subclass IVe.

999B—Ves-Estherville complex, 2 to 6 percent slopes. This map unit consists of well drained Ves soil and somewhat excessively drained Estherville soil. The soils are undulating, and they are on knolls and crests of ground and end moraines. The areas vary in shape and range from 3 to 20 acres in size.

Ves soil makes up about 65 percent of the map unit, and Estherville soil makes up about 20 percent. The individual areas of the soils are so intricately mixed or so small that it was not practical to separate them in mapping.

Typically, the Ves soil has a black loam surface layer about 9 inches thick. The subsoil is olive brown loam about 15 inches thick. The underlying material to a depth of at least 60 inches is light olive brown, calcareous loam that has an accumulation of lime in the upper part. In places the surface layer and the subsoil are sandy loam or loamy sand. In some areas, the surface layer is lighter in color and contains lime.

Typically, the Estherville soil has a black sandy loam surface layer about 10 inches thick. The subsoil is dark yellowish brown sandy loam about 6 inches thick. The underlying material is yellowish brown, calcareous coarse sand to a depth of at least 60 inches. In some areas, the underlying material is loam. Also, in some areas, it is stratified with sandy loam, silt loam, or loamy sand.

Included with these soils in mapping and making up about 15 percent of the map unit are small areas of Flom, Hawick, Lowlein, and Normania soils. Flom soils are poorly drained; they are in drainageways and concave swales. Hawick soils are excessively drained; they are randomly scattered throughout the mapped areas. Lowlein and Normania soils are moderately well drained; they are in less sloping, lower lying areas.

Permeability is moderate in the Ves soil. Permeability in the Estherville soil is moderately rapid in the upper part and rapid in the underlying material. The available water capacity is high in Ves soil and low in Estherville soil. The content of organic matter is high in Ves soil and moderate in Estherville soil. Natural fertility is high in Ves soil and low in Estherville soil. Surface runoff is medium on Ves soil and slow to medium on Estherville soil. The seasonal high water table is at a depth of more than 6 feet.

In most areas the soils are farmed. They are fairly well suited to corn, small grains, and forage grasses and legumes. Crop growth typically is variable and uneven because the sandy soils in the map unit are droughty. Management concerns are controlling erosion, maintaining fertility and tilth, and conserving moisture. Minimum tillage, returning crop residue to the soil, and proper crop rotation are effective in controlling erosion, improving tilth, and conserving moisture. Grassed waterways are needed in some areas to stop gullying. A balanced fertilization program and applications of manure help maintain fertility. Irrigation is difficult on these soils because they differ in intake rate and available water capacity.

The soils are well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help maintain a desirable plant community that produces good yields of forage. Overgrazing causes soil compaction, increases runoff, and reduces the quality of forage.

The soils are well suited to windbreaks and environmental plantings. Only trees and shrubs that tolerate droughty conditions should be selected for planting. Seedling mortality is moderate on the

Estherville soil because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while the seedlings are becoming established. Cultivation or herbicides help control competing vegetation, including weeds.

The soils are well suited to building site development. Erosion is a slight hazard during construction. In constructing roads across areas of the Ves soil, placing the roads on well compacted, coarse textured fill material helps prevent damage caused by low strength and frost action. The Ves soil is well suited to septic tank absorption fields, but the Estherville soil does not adequately filter the effluent. Consequently, suitable filter material must be used if absorption fields are placed in the Estherville soil.

These soils are in capability subclass IIIs.

999C—Ves-Estherville complex, 6 to 12 percent slopes. This map unit consists of well drained Ves soil and somewhat excessively drained Estherville soil. The soils are rolling and are on crests and knolls that have concave side slopes. The areas of this map unit vary in shape and range from 3 to 20 acres in size. Ves soil makes up about 65 percent of the map unit, and Estherville soil makes up about 25 percent. The areas of the individual soils are so intricately mixed or so small that mapping them separately was not practical.

Typically, the Ves soil has a black loam surface layer about 8 inches thick. The subsoil is dark brown loam about 14 inches thick. The underlying material to a depth of at least 60 inches is light olive brown, calcareous loam that has an accumulation of lime in the upper part. In some places, the surface layer and the subsoil are sandy loam or loamy sand. In other places, the surface layer has been mixed with the subsoil by plowing and has a brownish color.

Typically, the Estherville soil has a black sandy loam surface layer about 8 inches thick. The subsoil is dark yellowish brown sandy loam about 8 inches thick. The underlying material is yellowish brown, calcareous gravelly coarse sand to a depth of at least 60 inches. In some areas, the underlying material is loam. Also, in some places, it is stratified with sandy loam, silt loam, or loamy sand.

Included with these soils in mapping and making up about 10 percent of the map unit are small areas of Hawick soils. Hawick soils are excessively drained and are randomly scattered throughout the mapped areas.

Permeability is moderate in Ves soil. It is moderately rapid in the upper part of Estherville soil and rapid in the underlying material. The available water capacity is high in Ves soil and low in Estherville soil. The content of organic matter is high in Ves soil and moderate in Estherville soil. Natural fertility is high in Ves soil and low in Estherville soil. Surface runoff is medium on Ves soil and slow to medium on Estherville soil. The seasonal high water table is at a depth of more than 6 feet.

In most areas the soils are farmed. They are fairly well suited to corn, small grains, and forage grasses and legumes. Crop growth typically is variable and uneven because the sandy soils in the map unit are droughty. Management concerns are controlling erosion, maintaining fertility and tilth, and conserving moisture. Minimum tillage, returning crop residue, stripcropping, and proper crop rotation are effective in controlling erosion and conserving moisture. Grassed waterways are needed in some areas to stop gullying. A balanced fertilization program and applications of manure help maintain fertility.

The soils are fairly well suited to use as pasture. Pasture rotation, proper fertilization, and weed control help maintain a desirable plant community that produces good yields of forage. Overgrazing causes soil compaction, increases runoff, and reduces the quality of forage.

The soils are well suited to windbreaks and environmental plantings. Only trees and shrubs that tolerate droughty conditions should be selected for planting. Seedling mortality is moderate on the Estherville soil because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while the seedlings are becoming established. Cultivation or herbicides help control competing vegetation, including weeds.

The soils are well suited to building site development. Erosion can be a severe hazard during construction. Buildings should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Constructing roads on well compacted, coarse textured fill material helps prevent damage to the roads caused by low strength and frost action. Roads should be constructed on the contour, wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. The soils are poorly suited to septic tank absorption fields because of slope. Distribution lines should be placed on the contour. Also, the Estherville soil does not adequately filter the effluent. Consequently, suitable filter material must be used if absorption fields are placed in the Estherville soil.

These soils are in capability subclass IVe.

999D—Ves-Estherville complex, 12 to 25 percent slopes. This map unit consists of well drained Ves soil and somewhat excessively drained Estherville soil. The soils are moderately steep to steep. The areas of this map unit vary in shape and range from 3 to 30 acres in size. Ves soil makes up about 65 percent of the map unit, and Estherville soil makes up about 25 percent. The individual areas of the soils are so intricately mixed or so small that mapping them separately was not practical.

Typically, the Ves soil has a very dark brown loam surface layer about 7 inches thick. The subsoil is dark yellowish brown loam about 18 inches thick. The underlying material to a depth of at least 60 inches is light olive brown loam that has an accumulation of lime in the upper part. In some places, the surface layer is sandy loam or loamy sand. Also, in some areas, the surface layer has been mixed with the subsoil by plowing and is very dark grayish brown.

Typically, the Estherville soil has a black sandy loam surface layer about 7 inches thick. The subsoil is dark yellowish brown sandy loam about 8 inches thick. The underlying material is yellowish brown and light yellowish brown gravelly coarse sand to a depth of at least 60 inches. In some areas, the underlying material is loam. Also, in some places, it is stratified with sandy loam, silt loam, or loamy sand.

Included with these soils in mapping and making up about 10 percent of the map unit are small areas of Hawick soils. The excessively drained Hawick soils are randomly scattered throughout the mapped areas.

Permeability is moderate in Ves soil. In Estherville soil it is moderately rapid in the upper part and rapid in the underlying material. The available water capacity is high in Ves soil and low in Estherville soil. The content of organic matter is moderate in Ves soil, and natural fertility is high. The content of organic matter and natural fertility are low in Estherville soil. Surface runoff is medium to rapid on Estherville soil and rapid on Ves soil. The seasonal high water table is at a depth of more than 6 feet.

In most areas the soils are used as pasture. They are poorly suited to use as pasture. Pasture rotation and weed control help maintain a desirable plant community that produces a fair yield of forage. Overgrazing and pasturing during dry periods tend to destroy the plant cover, exposing the soils to erosion by wind and water.

In some areas the soils are farmed. They generally are not suited to crops because of the hazards of erosion and drought and the steep slopes. Crop growth is variable and uneven because of the contrasting characteristics of the soils. The less sloping soils in a few small areas are used for cultivated crops. Hay is the most common crop. Oats are grown only to reestablish permanent hay or pasture.

The soils are poorly suited to windbreaks and environmental plantings. Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Water erosion is a severe hazard unless the area is kept vegetated; site preparation should be limited to the area within 2 feet of the planting. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

Slope is the main limitation to use of the soils for building site development. Erosion can be a severe hazard during construction. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. The soils are poorly suited to septic tank absorption fields because of the steep slopes.

These soils are in capability subclass VIe.

1013—Pits, quarry. This map unit consists of granite quarries, adjacent stockpiles of unusable stone, and small areas of exposed bedrock. Quarries generally are located in areas of rock outcrops, which are mainly in St. Cloud, St. Augusta, Rockville, and Wakefield townships. The quarries are a source of granite used for monuments, markers, and building facades.

An area of this map unit typically consists of a deep hole from which granite is or has been removed. The vertical walls of the pit are 50 to 200 feet high. The stockpiles are made up of pieces of granite which either are of low quality or were damaged in quarrying operations. These stockpiles, which are next to the quarry, typically are 50 to 100 feet high.

Included in mapping are small areas of shallow soils that support sparse stands of such plants as drought-resistant grasses, shrubs, and stunted oaks.

Because the materials are highly variable, no soil interpretations have been made for these areas. Onsite investigation is necessary before making any land use decision.

This map unit was not assigned to a capability subclass.

1015—Psamments, sloping. These are sloping, somewhat excessively drained soils on till plains and outwash plains. The areas are made up of sandy soil materials that have been excavated or filled to prepare a site for a specific use. The areas are irregular in shape and range from 3 to 20 acres in size.

The soil material typically is loamy sand or sand; less commonly, it is gravelly loamy sand and gravelly sand. In some areas loamy material has been put back on the surface to provide a more suitable soil for plant growth.

Included in mapping and making up about 15 percent of most mapped areas are small areas that are nearly level or moderately steep.

Most areas are idle land that supports sparse grasses and shrubs. Because of the mixing and the variability of the soil materials involved, no soil interpretations have been made for these areas. Onsite investigation is necessary before making specific land use decisions.

These soils were not assigned to a capability subclass.

1016—Udorthents, loamy. This map unit consists of moderately fine textured to moderately coarse textured soils that have been mixed by filling and leveling operations. The soil material generally is from a nearby source. In some areas, the original soil has been removed to a depth of 5 to 20 feet or more; in other areas the topsoil has been redistributed. The soils range from somewhat excessively drained to somewhat poorly drained, depending upon the parent material of the soils, the landscape position, the condition to which the area has been restored, and the method used in restoration. The individual areas typically range from 5 to 30 acres in size. Slopes commonly range from 0 to 5 percent, but in some places they are as much as 15 percent.

The surface layer consists mainly of loamy soil material that has been redistributed to a depth of 4 to 20 inches. In most places the underlying material is a heterogeneous mixture of original topsoil, subsoil, and underlying material that originated from loamy glacial material. Cobbles, stones, and boulders are commonly used to fill deep cavities, especially in the eastern half of the county.

Included in mapping are some borrow areas near highways, freeway interchanges, rest areas, tank farms, and large right-of-ways. Also included are sand and gravel pits and some urban areas where concrete, asphalt, buildings, streets, and parking lots cover as much as 50 percent of the area.

The available water capacity varies, but it generally is moderate or low. Permeability varies because the soils have been compacted by construction equipment and because of the variability of the soil material. Organic matter content and fertility generally are low unless topsoil has been redistributed over the area. Erosion is active where the soil surface is not protected by vegetative cover.

In most areas, the Udorthents, loamy, are being used in some non-agricultural capacity and are not suited to cultivated crops. In some areas they have poor suitability for crops and pasture. If the sloping areas are cultivated, erosion is a moderate to severe hazard. Conservation tillage and other measures that disturb the soil as little as possible help stabilize the soil.

Udorthents, loamy, have a wide range of suitability for building site development. Slope, drainage, and permeability are moderate to severe limitations for septic tank absorption fields. Each site needs to be examined individually to determine its suitability for this use.

This map unit was not assigned to a capability subclass.

1018—Udifluvents, frequently flooded. This map unit consists of nearly level areas, 10 to 50 acres in size, of recently deposited, stratified alluvium on flood plains along the major rivers in the county. The areas are subject to frequent flooding, scouring, and cutting by streams. Many areas are dissected by old stream channels and some oxbows. These areas have parallel, short, narrow ridges that give them a corrugated appearance. Slopes range from 0 to 3 percent. The deposits are so recent that little or no development of distinct soil layers has taken place, although mottling is present.

The soil material ranges from fine sandy loam to coarse sand and generally is stratified. Color and reaction vary. The soils are well drained to somewhat poorly drained. A seasonally high water table ranges from 1 foot to 4 feet below the surface. Permeability varies; the range is from moderate to rapid. The available water capacity ranges from low to moderate, and natural fertility is medium. The content of organic matter is moderate. Runoff is slow.

In most areas the soils are farmed. They are suited to most of the crops commonly grown in the county. Flooding generally occurs in winter or early in spring before crops are planted. It commonly lasts 1 day to 4 days. The floodwater, on the average, is a few inches to 2 feet deep. The management concerns are flooding and droughtiness. If these soils are cultivated, wind erosion becomes a concern. Minimum tillage and a winter cover crop help to conserve moisture and to protect the soil from blowing. A balanced fertilization program, applying manure, and returning crop residue to the soil help improve fertility and tilth. As a water source is close by, irrigation can minimize the hazards of drought and wind erosion and supply adequate moisture for good crop yields.

The soils are well suited to use as pasture. The main management concerns are droughtiness and flooding. Pasture rotation, proper fertilization, and weed control help maintain a desirable plant community that produces high yields of quality forage. Deferring grazing early in spring and late in fall prevents damage to the pasture by browsing or trampling and allows the pasture plants to regain vigor.

The soils are well suited to a wide variety of trees and shrubs in windbreaks and environmental plantings. Untimely flooding can cause severe erosion and damage to seedlings unless the surface is protected by close-growing plant cover. Site preparation should be limited to the area within 2 feet of the plantings. Cultivation or herbicides can help control competing vegetation.

The soils generally are not suitable for building sites or septic tank absorption fields because of the hazard of flooding. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads by flooding.

These soils are in capability subclass IIIw.

1029—Pits, gravel. This map unit consists of excavations in outwash areas or pockets in till areas where sand and gravel have been removed and transported elsewhere for use. The individual areas are irregular in shape and range from 3 to 40 acres in size.

A few gravel pits have been leveled and shaped, and topsoil has been spread on the surface. These areas are used as cropland and pasture. The main concern in management is droughtiness.

Onsite investigation is necessary before making land use decisions for areas of this map unit.

This map unit was not assigned to a capability subclass.

1055—Histosols and Haplaquolls, ponded. This map unit consists of level, organic and mineral soils in shallow ponds, sloughs, and undrained closed depressions that are filled with water throughout most of the year. Some of the areas go dry late in summer or in years of drought, but most areas have open water during the growing season. The vegetation in the shallower parts and around the edges in an area consists of cattails, reeds, sedges, and other water-tolerant plants.

Included in this mapping are areas of sandy, loamy, organic, and calcareous mucky lake sediments. Open water normally covers the central part of a mapped area.

Most areas are left undeveloped. The areas generally are excellent habitat for wildlife. They provide nesting, mating, and escape areas for waterfowl, furbearers, and upland game.

This map unit was assigned to capability subclass VIIIw.

1064—Rock outcrop-Lithic Eutrochrepts complex. This map unit consists of areas of exposed bedrock and of shallow soils in the eastern part of the county, primarily in the townships of Rockville, St. Augusta, St. Cloud, LaSauk, and Wakefield. The granite exposures commonly project 5 to 10 feet above the surrounding land surface, but in places their height is as much as 20 to 50 feet. Of the various kinds of granite in the county, a gray granodiorite (*11*) is the most common.

Rock outcrop makes up about 55 percent of the map unit, and Lithic Eutrochrepts make up about 45 percent. Lithic Eutrochrepts are loamy soils that vary in texture from sandy loam to clay loam and have bedrock within 20 inches of the surface.

Most areas of this map unit are not used. The shallow soils support drought-resistant native grasses, shrubs, and bur oak trees. The areas are suited to such land uses as parks, wildlife sanctuaries, outdoor classrooms, and camping or recreation sites.

This map unit was assigned to capability subclass VIIIs.

1805—Blue Earth Variant mucky silt loam. This is a nearly level, very poorly drained soil in small to large depressions and lake basins. The areas vary in shape and range from 5 to 30 acres in size. This soil is subject to ponding.

Typically, the coprogenous earth sediment is about 28 inches thick. The uppermost 12 inches is black mucky silt loam; the middle 6 inches is very dark gray mucky silt loam; and the lower 10 inches is black mucky silt loam. The next layer is very dark grayish brown, mottled loam about 6 inches thick. The upper part of the underlying material is light brownish gray and olive gray gravelly loamy coarse sand 22 inches thick. The lower part is yellowish brown, mottled gravelly coarse sand to a depth of at least 60 inches. In places, the coprogenous earth is more than 40 inches or less than 16 inches thick. Also, in some areas there is a muck layer as much as 16 inches thick. In places, there is a layer of marl above the sand and gravel.

Permeability is moderate in the upper part and rapid in the underlying material. The available water capacity and the content of organic matter are high. Surface runoff is very slow or is ponded. Natural fertility is medium. The water table is within 1 foot of the surface throughout the year.

In most areas this soil is used as pasture or is idle and supports habitat for wildlife. This soil is poorly suited to use as pasture even if it is adequately drained. Hummocks tend to form if the pasture is overstocked. Proper fertilization, weed and brush control, and pasture rotation help maintain the desirable plant community. Adequate forage can be produced by seeding grasses that are tolerant of wetness and of high lime conditions.

The soil is poorly suited to cultivated crops. Wetness, low natural fertility, and wind erosion are the main concerns in management. Where outlets are available, subsurface drainage lines or open ditches can lower the water table. A balanced fertilization program, applying manure, and returning crop residue to the soil improve fertility and tilth. This soil is notably low in potassium and phosphorus. Because of the fertility imbalance, small grains tend to lodge, and corn and soybeans may not reach maturity. Maintaining crop residue on the surface and leaving the surface cloddy and rough reduce the hazard of soil blowing.

Without artificial drainage, this soil is well suited to use as habitat for wetland wildlife. It provides food, cover, and nesting sites for waterfowl, furbearers, and large and small upland game. In many places, the habitat can be improved for wildlife by creating additional areas of open water.

The soil has fair suitability for windbreaks and environmental plantings. Only trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe. Competing vegetation can be controlled by cultivation or by herbicides.

This soil is not suitable for building site development and for septic tank absorption fields because of ponding. If roads are to be built across areas of this soil, placing the roads on raised, coarse textured fill material and providing adequate side ditches and culverts help prevent damage to the roads caused by ponding, frost action, and low soil strength.

This soil is in capability subclass IVw.

1825C—Seelyeville muck, sloping. This is a nearly level to gently sloping, very poorly drained soil on convex side slopes and toe slopes. The areas vary in shape and range from 5 to 100 acres in size.

Typically, the organic layers are very dark brown and black muck to a depth of at least 60 inches. In some places the organic material is less than 51 inches thick. Typically, there is an accumulation of lime at or near the surface.

Permeability is moderate to moderately slow. The available water capacity and the content of organic matter are high. Natural fertility is low. Surface runoff is slow. The water table is within 2 feet of the surface throughout the year.

In most areas this soil is used as pasture; however, it is poorly suited to this use. Hummocks typically form in pastured areas because of the wet soil condition. Drainage is needed to permit cultivation of crops and to improve pastured areas. Open ditches and subsurface drainage lines are the most commonly used methods. Draining this soil is difficult because it is hard to locate and intercept all of the seepage areas.

This soil generally is not suited to cultivated crops because of wetness and the difficulty of providing adequate drainage.

This soil is not suited to building site development and septic tank absorption fields because of wetness and low strength. Where roads are built on this soil, constructing the roads on raised, coarse textured fill material and providing adequate side ditches and culverts minimize the damage caused by frost action and low strength.

This soil is in capability subclass VIw.

1828—Glencoe muck. This is a nearly level, very poorly drained soil in depressions on uplands. The areas vary in shape and range from 5 to about 20 acres in size. This soil is subject to ponding.

Typically, the surface layer is very dark brown muck about 12 inches thick. The subsurface layer is black loam about 16 inches thick. The subsoil is olive gray, mottled loam about 5 inches thick. The underlying material is olive gray, mottled, calcareous loam to a depth of at least 60 inches. In some places, the subsoil is thicker or thinner than is typical; the depth to lime corresponds to the thickness of the subsoil. Also, in some areas the organic surface layer is mildly alkaline.

Included with this soil in mapping and making up about 15 percent of the map unit are small areas of Bluffton and Cathro soils, which are in positions similar to those of the Glencoe soil and which are also very poorly drained. Bluffton soils do not have an organic surface layer. Cathro soils formed in organic material more than 16 inches thick.

Permeability is moderate, and the available water capacity is high. The content of organic matter is high, and natural fertility is low. Surface runoff is very slow or is ponded. The seasonal high water table is within 1 foot of the surface.

In most areas, this soil is in a natural state and provides habitat for wetland wildlife. It is poorly suited to corn, small grains, and forage grasses and legumes. Excess water, fertility levels, and soil blowing are the main concerns in management. Wetness and ponding can be controlled, where adequate outlets are available, by open ditches and subsurface drainage lines with surface inlets. Removing excess water permits earlier planting. Maintaining a proper balance of nutrients by fertilization can minimize lodging of small grains and permit corn to reach maturity. Returning crop residue to the soil and tillage that leaves the surface rough and cloddy help prevent soil blowing.

Without artificial drainage, this soil is well suited to use as habitat for waterfowl, furbearers, and big and small game. Creating areas of open water further improves the habitat for wetland wildlife.

The soil is poorly suited to windbreaks and environmental plantings. Only trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe because of wetness. Cultivation or herbicides can help control competing vegetation.

The soil generally is not suited to building site development and septic tank absorption fields because of wetness and the hazard of ponding. If roads are built on this soil, the roads should be placed on raised, coarse textured fill material to prevent damage caused by ponding and by frost action.

This soil is in capability subclass IVw.

1842F—Cushing and Flak sandy loams, steep. These Cushing and Flak soils include the steepest soils in the county. The Cushing and Flak soils are well drained and are on complex bluffs and summits on ground and end moraines. The areas vary in shape and range in size from 5 to 50 acres. The slopes range from 25 to 40 percent. The soils are intermingled on the landscape in an irregular pattern. They could have been mapped individually but were mapped as one unit because similar interpretations can be made for use and management. An area can be made up of only one of the major soils, or it can be made up of both soils.

Typically, the Cushing soil has a surface layer of very dark brown sandy loam about 4 inches thick. The subsurface layer is dark grayish brown sandy loam about 11 inches thick. The subsoil is dark brown sandy loam and loam and is about 32 inches thick. The underlying material is dark brown sandy loam to a depth of at least 60 inches. In some small areas the subsoil and the underlying material are more yellow than is typical.

Typically, the Flak soil has a surface layer of very dark brown fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 11 inches thick. The subsoil is dark brown sandy loam

about 28 inches thick. The underlying material is dense, dark brown sandy loam to a depth of at least 60 inches. In some small areas there is loamy sand in the subsoil and in the underlying material.

Included in mapping and making up about 10 percent of some mapped areas are small areas of DeMontreville and Mahtomedi soils. The DeMontreville soils are well drained. Their surface layer and the upper part of the subsoil are sandy and are underlain by sandy loam glacial till. The DeMontreville soils are in less sloping positions than Cushing and Flak soils. The Mahtomedi soils are excessively drained and are sandy throughout. They are in positions on the landscape similar to those of Cushing and Flak soils. Also included are small areas of soils that have slopes of less than 25 percent or more than 40 percent.

Permeability of the Cushing and Flak soils is moderately slow, and the available water capacity is moderate. The content of organic matter is low, and natural fertility is medium. The seasonal high water table is at a depth of more than 6 feet.

The soils making up this map unit are used mainly as woodland or wooded pasture. The soils are well suited to use as woodland and to environmental plantings. Windbreaks generally are not suitable because of the steep slopes. The main management concerns are plant competition, droughtiness on slopes facing south and west, restrictions on the use of equipment, and soil erosion. Cutting, spraying, girdling, and prescribed burning control competing vegetation. Mulching, timely planting, planting drought-tolerant species, and planting on slopes that face north and east reduce seedling mortality. Soil erosion can be controlled by maintaining an adequate ground cover.

The soils generally are not suited to crops because of the steep slopes. Erosion is a very severe hazard. The soils are poorly suited to use as pasture. The major management concerns are the steep slopes and the hazard of erosion. Overgrazing the pasture can cause surface compaction, excessive runoff, and poor tilth. Proper pasture management reduces excessive runoff and increases forage production.

These soils are well suited to a wide variety of trees and shrubs in environmental plantings. Water erosion is severe unless the area is kept vegetated; therefore, site preparation should be restricted to the area within 2 feet of the planting. Cultivation or herbicides help control competing vegetation.

Slope is the main limitation in using these soils for building site development. Erosion is a very severe hazard during construction. Extensive land shaping is generally needed. Buildings should be designed to conform to the natural slope. Extensive cuts and fills generally are necessary in road construction on these soils. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize the erosion hazard. These soils generally are not suited to septic tank absorption fields because of the steep slopes.

These soils are in capability subclass VIIe. The Cushing soil is in woodland suitability group 2r, and the Flak soil is in woodland suitability group 2d.

1843C—Cushing-DeMontreville complex, 8 to 15 percent slopes. This map unit consists of rolling, well drained soils on knolls and concave side slopes on ground and end moraines. The areas vary in shape and range from 5 to 50 acres in size. This complex is about 50 percent Cushing soil and 35 percent DeMontreville soil. The soils are in similar positions on the landscape. The areas of the soils are so intricately mixed or so small that it was not practical to separate them in mapping.

Typically, the Cushing soil has a surface layer of dark grayish brown sandy loam about 6 inches thick. The subsurface layer is dark brown sandy loam about 9 inches thick. The subsoil is dark brown sandy clay loam about 15 inches thick. The underlying material is dark brown, noncalcareous sandy loam to a depth of at least 60 inches. In places the subsoil and underlying material are finer textured and have a yellower hue than is typical.

Typically, the DeMontreville soil has a surface layer of very dark brown loamy sand about 2 inches thick. The subsurface layer is dark grayish brown, yellowish brown, and brown loamy sand and loamy coarse sand and is about 16 inches thick. The subsoil is dark brown sandy clay loam and is also about 16 inches thick. The underlying material is dark brown, noncalcareous coarse sandy loam to a depth of at least 60 inches. In some small areas the sandy mantle is more than 40 inches thick.

Included in mapping and making up about 15 percent of some mapped areas are small areas of Nokay and Prebish soils. The somewhat poorly drained Nokay soils and the very poorly drained Prebish soils are closely intermingled in depressions and drainageways.

Permeability is moderately slow in Cushing soil. In DeMontreville soil it is rapid in the sandy mantle and moderately slow in the underlying material. The available water capacity is moderate in both soils. The content of organic matter is low. Natural fertility is medium in Cushing soil and low in DeMontreville soil. Surface runoff is slow to medium on both soils. The seasonal high water table is at a depth of more than 6 feet.

These soils are used mainly for crops and as pasture. They are fairly well suited to corn, small grains, and forage grasses and legumes. The major concerns in management are the hazards of erosion and drought and, in many areas, stones on the surface. Conservation tillage, contour stripcropping, returning crop residue to the soil, applying manure, and a crop rotation system that includes grasses and legumes are effective in controlling erosion and maintaining tilth and fertility and

also help conserve moisture. Stones in these soils are brought to the surface by tillage and by frost action. Tillage is easier and there is less risk of damage to equipment if the stones are removed periodically. Grassed waterways help prevent excessive soil loss. Liming increases the effectiveness of fertilizers and improves grass and legume stands and yields.

The soils are fairly well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce good yields of forage.

The soils have fair suitability for windbreaks and environmental plantings. Trees and shrubs that can withstand droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in the seedlings. Some vegetation should be left on the surface while young trees are becoming established to protect them from injury by soil blowing. Controlling weeds and other competing vegetation by cultivation or by herbicides helps reduce plant competition for moisture.

The soils are fairly well suited to use as woodland. The major concerns in management are seedling mortality and plant competition. Shallow tillage, mulching, and timely planting conserve moisture and reduce seedling mortality. Planting species that withstand drought also helps reduce seedling losses. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning help control competing vegetation.

The soils are well suited to building site development. Erosion is a hazard because of the slope. Land shaping may be needed in some areas. Roads should be placed on the contour wherever possible, and roadbanks should be planted to well-adapted grasses to minimize erosion. Using well compacted, coarse-textured fill material in road construction helps prevent damage to the roads by frost action. The soils are poorly suited to septic tank absorption fields because of the slope and because their moderately slow permeability retards absorption of the effluent. Land shaping and installing the distribution lines on the contour generally are necessary for a septic tank absorption field to work properly. Also, the drain field should be made large enough for adequate discharge of effluent into the soil.

These soils are in capability subclass IVe. Cushing soil is in woodland suitability group 2o, and DeMontreville soil is in woodland suitability group 3s.

1843E—Cushing-DeMontreville complex, 15 to 25 percent slopes. This map unit consists of hilly to steep, well drained soils on side slopes and hillsides on ground and end moraines. The areas vary in shape and range from 5 to 60 acres in size. Cushing soil makes up about 45 percent of the map unit, and DeMontreville soil makes up about 40 percent. The soils are in similar positions on the landscape. The areas of Cushing and DeMontreville soils are so intricately mixed or so small that it was not practical to separate them in mapping.

Typically, the Cushing soil has a surface layer of very dark grayish brown sandy loam about 4 inches thick. The subsurface layer is dark grayish brown sandy loam about 7 inches thick. The subsoil is sandy clay loam about 14 inches thick. It is brown in the upper part and dark brown in the lower part. The underlying material is brown, noncalcareous sandy loam to a depth of at least 60 inches. In some places the subsoil and underlying material are finer textured and have a yellower hue.

Typically, the DeMontreville soil has a surface layer of very dark grayish brown loamy sand about 2 inches thick. The subsurface layer is dark brown loamy sand and coarse sand and is about 15 inches thick. The subsoil is dark brown and strong brown sandy loam about 15 inches thick. The underlying material is dark brown, noncalcareous sandy loam to a depth of at least 60 inches. In some small areas the sandy material is more than 40 inches thick.

Included in mapping and making up about 15 percent of some mapped areas are small areas of Nokay and Prebish soils. The somewhat poorly drained Nokay soils and the very poorly drained Prebish soils are closely intermingled in depressions and potholes.

Permeability is moderately slow in the Cushing soil. Permeability in the DeMontreville soil is rapid in the sandy upper part and moderately slow in the loamy material. The available water capacity is medium and the content of organic matter is low in both soils. Natural fertility is low in the DeMontreville soil and medium in the Cushing soil. Surface runoff is rapid. In both soils, the seasonal high water table is at a depth of more than 6 feet.

In most areas the soils are used as woodland or wooded pasture. They are fairly well suited to use as woodland. The main concerns in management are equipment limitations, seedling mortality caused by droughtiness on south- and west-facing slopes, plant competition, and erosion. Seedling mortality caused by droughtiness can be lowered by mulching, timely planting, planting only those species that withstand drought, and planting on north- and east-facing slopes. Site preparation and cutting, spraying, girdling, or prescribed burning control competing vegetation. Ground cover should be maintained to control erosion.

The soils are generally not suited to use as cropland because of the steepness of the slope and the hazard of erosion. They are poorly suited to use as pasture. Overgrazing the pasture can cause surface compaction, excessive runoff, and poor tilth. Proper fertilization, liming, weed control, pasture rotation, and proper stocking help to maintain a desirable plant community and to produce good yields of forage.

The soils are fairly well suited to windbreaks and environmental plantings. Trees and shrubs that are

tolerant of droughty conditions should be selected for windbreaks and environmental plantings. Seedling mortality is moderate because the low available water capacity causes moisture stress in seedlings. Some vegetation should be left on the surface to reduce soil blowing while young trees are becoming established. Water erosion is a severe hazard unless the area is kept vegetated; site preparation should be limited to the area within 2 feet of the plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

Slope is the main limitation to use of the soils for building site development. Erosion is a severe hazard during construction. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. Extensive cuts and fills generally are needed in road construction. Roads should be placed on the contour, and roadbanks should be planted to well-adapted grasses to minimize erosion. The soils generally are not suited for use as septic tank absorption fields because of the slope.

These soils are in capability subclass VIe. The Cushing soil is in woodland suitability group 2r, and the DeMontreville soil is in group 3s.

1879—Seelyeville muck, calcareous. This is a nearly level, very poorly drained soil in depressions. The areas vary in shape and range in size from 5 to 80 acres. This soil is subject to frequent flooding and ponding.

Typically, the organic layers are very dark brown and black muck to a depth of at least 60 inches. In some places, the organic matter is less than 51 inches thick. In some areas the soil is neutral or slightly acid throughout.

Permeability is moderate to moderately slow, and the available water capacity is high. The content of organic matter is high, and natural fertility is low. Surface runoff is very slow or is ponded. The water table is within 2 feet of the surface throughout the year.

In most areas this soil is in a natural state and provides habitat for wetland wildlife, to which it is well suited. Creating areas of open water improves the habitat for waterfowl, furbearers, and game animals.

The soil is poorly suited to corn, small grains, and forage grasses and legumes. Excess water, low fertility, and soil blowing are the main concerns in management. Wetness and ponding can be controlled by open ditches where adequate outlets are available. Removing excess water permits earlier planting and helps minimize ponding. Maintaining a proper balance of nutrients by adding fertilizers can minimize lodging of small grains. The return of crop residue to the soil and tillage that leaves the surface rough and cloddy help to minimize soil blowing.

The soil is poorly suited to use as pasture. Grazing when the soil is wet or overgrazing causes hummocks to form. Proper stocking rates, pasture rotation, fertilization, restricted use during wet periods, and improved drainage help establish and maintain grasses that produce high yields of forage.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate wetness should be selected for planting. Seedling mortality is severe because of ponding and wetness. Competing vegetation can be controlled by cultivation or herbicides.

The soil is not suitable for building site development and septic tank absorption fields because of flooding and ponding. In building roads across areas of this soil, placing the roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to prevent damage to the roads by flooding, ponding, and frost action.

This soil is in capability subclass IVw.

1880—Martisco mucky silt loam. This is a nearly level, very poorly drained soil in shallow lake basins and marshes on moraines and outwash plains. The areas vary in shape and range in size from 10 to 90 acres. This soil is subject to occasional flooding and to ponding.

Typically, the surface layer is dark gray, calcareous mucky silt loam about 9 inches thick. The underlying material is light gray, grayish brown, and olive gray marl to a depth of at least 70 inches. In some places the loamy mineral soil overlying the marl is thicker and extends to a depth of as much as 36 inches.

Included with this soil in mapping and making up 5 to 15 percent of the map unit are small areas of Blue Earth Variant and of Seelyeville calcareous soils. Blue Earth Variant soils formed in 16 to 40 inches of dominantly limnic material. Seelyeville calcareous soils formed in more than 51 inches of calcareous sapric material.

Permeability of this soil is slow. The available water capacity is high. Surface runoff is very slow or is ponded. Natural fertility is low. The content of organic matter is high. The seasonal high water table is within 0.5 foot of the surface.

In most areas this soil is in native vegetation and provides habitat for wetland wildlife. The soil is well suited to this use. Protecting the areas from grazing preserves the plant cover for nesting and roosting sites and for escape routes.

This soil is a source of lime for agricultural use.

The soil is poorly suited to crops. It is not suitable for use as pasture because of the high water table and ponding.

The soil is poorly suited to windbreaks and environmental plantings. Only those trees and shrubs that tolerate extreme wetness should be selected for planting. Seedling mortality is severe because of flooding and wetness. Cultivation or herbicides can help control competing vegetation, including weeds.

This soil is not suitable for building site development and septic tank absorption fields because of flooding and ponding. Constructing roads on raised, coarse

textured fill material and providing adequate side ditches and culverts help to protect the roads from damage caused by flooding, ponding, and low soil strength.

This soil is in capability subclass IVw.

1892—Prebish fine sandy loam. This is a level, poorly drained soil in broad areas of low relief on ground and end moraines and on flats between drumlins. The individual areas vary in shape and range from 5 to 50 acres in size. This soil is subject to ponding.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsurface layer is very dark gray fine sandy loam about 5 inches thick. The subsoil is mottled, grayish brown sandy loam about 30 inches thick. The underlying material is mottled, dark reddish brown sandy loam to a depth of at least 60 inches.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Nokay soils. The somewhat poorly drained Nokay soils are on the same landscape. They do not have a thick surface layer.

Permeability is moderately slow. The available water capacity is moderate. The content of organic matter is high, and natural fertility is medium. Surface runoff is slow or is ponded. The water table is within 1 foot of the surface throughout the year.

About half of the acreage of this soil is farmed. The other half is used as pasture and woodland. This soil is poorly suited to corn, small grains, and forage grasses and legumes. Drainage and maintenance of tilth are needed to keep the soil suitable for good crop production. Good tilth can be maintained by returning crop residue to the soil or by a crop rotation that includes forage grasses and legumes that tolerate occasional ponding and wet soil conditions. Deep tillage helps aerate the soil. Fall plowing helps this soil to warm up and become workable earlier in the spring.

The soil is well suited to use as pasture. Grazing when the soil is wet and overgrazing cause surface compaction and poor tilth. Many pastures are wooded or brushy. Clearing them improves the quantity and quality of forage. Proper stocking rates, pasture rotation, and fertilization help maintain a stand of desirable grasses that produce high yields of forage.

The soil is well suited to windbreaks and environmental plantings. However, only trees and shrubs that tolerate a very high water table and occasional ponding should be selected for plantings. Seedling mortality is severe because of ponding and wetness. Cultivation or herbicides help control competing vegetation, including weeds.

The soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without basements, and land shaping should be designed to drain surface water away from building foundations. Tile drains around the foundations help to remove excess subsurface water. Constructing roads on raised, coarse textured fill material and providing adequate side ditches and culverts help to overcome the wetness and to prevent damage to the roads by frost action. This soil is poorly suited to septic tank absorption fields because of wetness. Subsurface drains are needed to keep the highest level of the water table 3 feet below the seepage trench. In places a mound system can be installed: the septic tank absorption field is laid out in suitable loamy material that has been placed on the surface.

This soil is in capability subclass IVw.

1902B—Jewett silt loam, 2 to 8 percent slopes. This is a gently sloping, well drained soil on crests and side slopes on ground and end moraines. The areas vary in shape and range from 5 to 60 acres in size.

Typically, the surface layer is very dark brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown and brown silt loam about 9 inches thick. The subsoil is about 31 inches thick. The upper part is dark yellowish brown silt loam, and the lower part is dark yellowish brown and yellowish brown loam and fine sandy loam. The underlying material is yellowish brown, noncalcareous loam to a depth of at least 60 inches. In some places the silty mantle is more than 30 inches thick. In some areas the soil is moderately well drained.

Included with this soil in mapping and making up 5 to 15 percent of some mapped areas are small areas of Cushing, Nokay, and Prebish soils. The well drained Cushing soils formed in sandy loam glacial till on the same landscape as the Jewett soil, but they do not have a silty mantle. The somewhat poorly drained Nokay soils and the very poorly drained Prebish soils are closely intermingled in depressions and drainageways.

Permeability is moderate. The available water capacity is high. The content of organic matter is low, and natural fertility is medium. Surface runoff is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for crops. It is well suited to most of the crops commonly grown in the county. The major concern in management is the hazard of erosion. Conservation tillage, contour farming, returning crop residue, applying manure, and crop rotation are effective in controlling erosion, maintaining tilth and fertility, and conserving moisture. Grassed waterways help prevent excessive soil loss. Liming increases the effectiveness of fertilizers and improves legume stands.

The soil is well suited to use as pasture. Proper fertilization, liming, weed control, and pasture rotation help to maintain a desirable plant community and to produce high yields of forage.

The soil is well suited to a wide variety of trees and shrubs for windbreaks and environmental plantings. Weeds and other competing vegetation can be controlled by cultivation or by herbicides.

The soil is well suited to use as woodland. Plant competition is the major concern in management. Site preparation, cultivation of the soil, and cutting, spraying, girdling, or prescribed burning can control competing vegetation.

The soil is fairly well suited to building site development. If buildings are constructed on this soil, foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Backfilling around foundations with suitable coarse material provides added protection against structural damage. Constructing roads on well compacted, coarse textured base material helps prevent damage to the roads by frost action and by shrinking and swelling. Because of its moderate permeability, this soil does not readily absorb effluent in a septic tank absorption field. A larger than average drain field helps overcome this limitation.

This soil is in capability subclass IIe and in woodland suitability group 2o.

Prime Farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Stearns County are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not subject to frequent flooding during the growing season. The slope ranges mainly from 0 to 6 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations or hazards are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

About 407,400 acres, or nearly 46 percent of Stearns County, is prime farmland. The areas are scattered throughout the county, but they are mainly in associations 5, 7, 8, 9, 10, 11, 12, 13, and 14 on the general soil map.

A recent trend in land use in some parts of the county has been the conversion of some prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, or difficult to cultivate and less productive than prime farmland.

The following map units, or soils, make up prime farmland in Stearns County. If a soil is considered to be prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

5A	Dakota loam, 0 to 2 percent slopes
5B	Dakota loam, 2 to 6 percent slopes
25	Becker fine sandy loam
32B	Nebish sandy loam, 2 to 8 percent slopes
36	Flom loam (where drained)
38B	Waukon loam, 2 to 6 percent slopes
72	Shooker loam (where drained)
109	Cordova loam (where drained)
125	Beltrami loam
129	Cylinder loam
133B	Dalbo loam, 2 to 8 percent slopes
142	Nokay fine sandy loam (where drained)
144B	Flak sandy loam, 4 to 8 percent slopes
156A	Fairhaven loam, 0 to 2 percent slopes
156B	Fairhaven loam, 2 to 6 percent slopes
163B	Brainerd fine sandy loam, 1 to 4 percent slopes
180A	Gonvick loam, 1 to 2 percent slopes
180B	Gonvick loam, 2 to 4 percent slopes
200B	Holdingford sandy loam, 4 to 8 percent slopes
204B	Cushing sandy loam, 2 to 8 percent slopes
233B	Growton sandy loam, 1 to 4 percent slopes
236	Vallers loam (where drained)
255	Mayer loam (where drained)
281	Darfur coarse sandy loam (where drained)

292B	Alstad sandy loam, 1 to 4 percent slopes
392	Biscay loam (where drained)
414	Hamel loam (where drained)
421B	Ves loam, 2 to 6 percent slopes
446A	Normania loam, 1 to 3 percent slopes
446B	Normania loam, 3 to 5 percent slopes
459	Corunna loam (where drained)
461B	Koronis loam, 2 to 6 percent slopes
511	Marcellon loam
571	Coriff loam (where drained)
572	Lowlein sandy loam
582	Roliss loam (where drained)
591B	Doland silt loam, 1 to 6 percent slopes
597	Tara silt loam
639A	Ridgeport sandy loam, 0 to 2 percent slopes
639B	Ridgeport sandy loam, 2 to 6 percent slopes
1902B	Jewett silt loam, 2 to 8 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Some basic management practices are needed on almost all of the soils that are used for crops and pasture. The following paragraphs discuss basic practices needed in controlling erosion, providing drainage, preserving tilth, maintaining fertility, conserving moisture, and irrigating. Technical assistance in planning and applying practices suitable for the soils on a particular farm can be obtained from the local office of the Soil Conservation Service.

Erosion control. Water erosion is a hazard on the sloping soils. To control water erosion it is necessary to reduce runoff and increase the water intake. This can be done by contour cultivation, terracing, stripcropping, minimum tillage, grassed waterways, and proper use of crop residue. Maintaining a high content of organic matter and a high level of fertility helps increase the infiltration of water and enables the soil to support crops that improve its structure.

Soil blowing occurs throughout the survey area, but it is less serious than water erosion. It is more serious on the sandy soils in the southwestern and eastern parts of the survey area than on other soils. It can, however, be controlled by maintaining a cover of plants or of crop residue and by conservation tillage, stripcropping, wind stripcropping, and the use of field windbreaks to protect exposed areas. Areas subject to soil blowing need a cropping system that provides a cover of residue in winter and early in spring when soil blowing is most likely to occur.

Drainage. Drainage is needed for intensive cropping of wet and level or depressional soils. Tile drains work in some areas, and surface ditches may be adequate to remove surface water in others. In areas where the lower part of the soil is sandy or gravelly, however, it is difficult to install tile and to maintain open drains.

Root development is good in soils that are adequately drained because the movement of air and water into and through the soil is not restricted. Soils that are adequately drained generally warm up earlier in spring than other soils. Effective drainage makes field operations possible earlier in the season than in undrained areas.

Tillage. Frequent tillage or tilling when the soils are too wet or too dry damages the structure of the soils. Frequent tillage makes the surface layer powdery so that water is not adsorbed readily. Runoff increases, making less moisture available to plants and increasing the hazard of erosion. Tilling when the soil is too wet makes the surface layer cloddy and undesirable as a seedbed. Tillage should be restricted to the amount required to prepare a good seedbed, to control weeds, and to control volunteer growth of crops from the previous year. Tillage can be further reduced if chemicals are applied to control weeds and if machinery is used that performs minimum tillage.

Fall plowing is a common practice, but tillage other than rough plowing should be avoided in fall. A rough surface holds the moisture from melting snow and reduces the hazard of erosion. Freezing and thawing in winter help break up the clods and make tillage easier in the spring. Soils that were plowed in the fall can be tilled earlier in spring than other soils. As a result, a better seedbed can be prepared and the potential for a good stand of plants is increased.

Sloping soils can be protected from excessive soil loss by using minimum tillage and by properly managing all crop residue. These practices help to control erosion and to provide a better seedbed. Wherever possible, sloping soils should be cultivated on the contour. Fall plowing is suitable if such soils are terraced and if manure or some other protective mulch is used.

Fertilization. The soils in Stearns County vary widely in their need for lime and fertilizer. The amounts used depend on the natural acidity of the soil, the previous management, and the cropping system that is planned. The soils should be tested once during the cropping system, or about every 3 to 5 years, to determine the need for lime and fertilizer. Tests should be conducted by a reliable laboratory which provides an analysis and interprets the results.

Moisture conservation. On droughty, sandy soils, practices are needed that conserve moisture. A comprehensive program can include controlling wind erosion, limiting runoff, increasing water infiltration, and controlling weeds. Measures that help are field windbreaks, stripcropping, minimum tillage, maximum use of crop residue, and planting early-maturing crops.

Irrigation. In 1980 approximately 27,000 acres in this survey area was irrigated. Wells are the primary source of irrigation water. Factors to be considered in planning an irrigation system are the soil type, amount and quality of water needed, type of irrigation system needed, and the preparation and drainage and overall management of the land. Good management requires a knowledge of water application: the amount required, when to apply it, and how to distribute it evenly. Also, crops on most irrigated soils need to be fertilized if they are to benefit fully from irrigation. Help in planning an irrigation system can be obtained from the local office of the Soil Conservation Service, the Agricultural Extension Service of the University of Minnesota, and local dealers in irrigation equipment.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they make allowance for possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only

class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w,* or *s,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); and *s* shows that the soil is limited mainly because it is shallow, droughty, or stony.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Woodland Management and Productivity

Stearns County is partly within the northern deciduous forest region that is commonly referred to as the Big Woods. Almost two-thirds of the county was originally covered with forest. The native species include quaking aspen, bur oak, northern red oak, white oak, basswood, elm, ash, birch, hard maple, soft maple, wild cherry, hophornbeam, cottonwood, and willow.

A large prairie area existed in the western part of the county. Its boundary extended from Sauk Centre southeast along the Sauk River to the village of Richmond, then southwest along the route of State Highway 23 to the county line. Numerous small prairie enclaves existed within the forested area. One was south of the village of Clearwater; another was west of the city of St. Cloud and extended southwest of the village of St. Joseph; and a third was in the Main Prairie area north of the village of Kimball.

Of the several forest types in the county, Aspen-Oak is the largest in acreage; Big Woods is about equal in acreage to Oak Openings and Barrens; Conifer Bogs and Swamps is next, and River Bottom Forest is the smallest in acreage (*6*).

Much of the remaining woodland in the county is in small tracts. Wood production is limited. Many wooded areas are used for homesites and recreation, and some are grazed.

Table 6 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 6, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that few trees may be blown down by strong winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and tall-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or from a nursery.

Recreation

The many lakes, rivers, and streams, the rolling wooded hills, and the picturesque scenery in Stearns County provide ample opportunity for recreational development. Ideal picnic areas and campsites and scenic overlooks are along the major rivers and among the larger hills. Events in early Minnesota history are commemorated at numerous sites throughout the county. The many lakes in the county are used for boating, swimming, and fishing. Public access areas are provided on the larger lakes and rivers. Numerous parks have hiking and biking trails, swimming beaches, and other recreational facilities. Because city dwellers in increasing numbers are turning to outdoor recreation, the owners of openland, woodland, and lakeshore have an opportunity to develop new and potentially profitable facilities for camping, hiking, skiing, fishing, golfing, and other forms of recreation.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary

facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

The soils of Stearns County have the potential to provide excellent habitat for various kinds of wildlife. This county is in the borderline area for several major wildlife species. The number of animals of any one species may be lower than in more favored areas within the range of the species. In scattered areas of Stearns County, the natural habitat of many kinds of wildlife has been changed or destroyed by urbanization.

The wildlife in Stearns County includes several species of migratory waterfowl; mink, muskrat, and other small furbearers that inhabit water areas; grouse, pheasant, and other upland game birds; rabbits; fox, squirrel, and other small mammals; and deer.

Some of the lakes in the county that afford good fishing are Sauk, Koronis, Rice, Big Birch, Big Fish, and Big Spunk. The principal sport fish are walleye, northern pike, bass, crappie, and sunfish. The Mississippi River has good fishing for walleye, northern pike, muskellunge, bass, and crappie.

Wildlife populations can be increased by using a crop rotation, planting crops in strips, and seeding ditchbanks and field borders to provide a variety of cover that is attractive and beneficial to wildlife.

Scattered throughout the western two-thirds of the county are tracts of land set aside to preserve the natural wetlands. These areas provide excellent habitat and are used by large numbers of waterfowl and pheasants.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features

that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of

construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable

properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil

layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable

material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops.

They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Tables 16 and 17 give estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*10*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquoll (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*9*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*10*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Alstad Series

The Alstad series consists of deep, somewhat poorly drained, moderately permeable soils on ground and end moraines. The soils formed in noncalcareous, loamy glacial till. Slopes range from 1 to 4 percent.

Alstad soils are similar to Brainerd soils and adjacent on the landscape to Cushing, Nokay, and Prebish soils. Unlike Alstad soils, Brainerd soils do not have an argillic B horizon; they have fragic characteristics in the lower B and C horizons. Cushing soils are in more sloping areas. Nokay and Prebish soils are in depressions and drainageways.

Typical pedon of Alstad sandy loam, 1 to 4 percent slopes, 1,680 feet west and 1,420 feet south of the northeast corner of sec. 14, T. 123 N., R. 29 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium granular structure; friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.

E—7 to 13 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; common fine distinct dark brown (7.5YR 3/2) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; medium acid; clear wavy boundary.

Bt1—13 to 22 inches; dark brown (7.5YR 4/3) sandy clay loam; common medium faint dark brown (7.5YR 4/2) and strong brown (7.5YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; about 10 percent coarse fragments; medium acid; clear wavy boundary.

Bt2—22 to 35 inches; dark brown (7.5YR 4/4) sandy clay loam; common medium distinct dark reddish gray (5YR 4/2) and yellowish red (5YR 5/6) mottles; moderate medium subangular blocky structure; friable; common moderately thick dark brown (7.5YR 3/2 and 4/2) clay films on faces of peds and lining voids; about 10 percent coarse fragments; medium acid; gradual wavy boundary.

Bt3—35 to 46 inches; dark brown (7.5YR 4/4) sandy loam; common medium distinct dark reddish gray (5YR 4/2) and dark reddish brown (5YR 3/4) mottles; moderate coarse subangular blocky structure; friable; few moderately thick dark brown (7.5YR 3/2) clay films on faces of peds and lining voids; about 10 percent coarse fragments; slightly acid; gradual wavy boundary.

C—46 to 60 inches; dark brown (7.5YR 4/4) sandy loam; massive; friable; about 10 percent coarse fragments; neutral.

The solum is 30 to 60 inches thick. Free carbonates generally are leached to a depth of 60 inches or more. Coarse fragments of gravel size range from 2 to 20 percent, by volume, in parts of the solum.

The A horizon has value of 2 through 4 and chroma of 1 through 4. It is sandy loam or fine sandy loam. Reaction ranges from medium acid to neutral. In some pedons there is an A&B or a B&A horizon.

The B horizon has hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 3 or 4. It is sandy loam or sandy clay loam, but individual subhorizons are fine sandy loam, loam, or coarse sandy loam. Reaction ranges from strongly acid to slightly acid.

The C horizon has value of 3 through 5 and chroma of 4 through 6. Reaction ranges from medium acid to neutral.

Anoka Series

The Anoka series consists of well drained, moderately rapidly permeable soils on outwash plains and deltas. The soils formed in stratified sandy and loamy material. Slopes range from 2 to 8 percent.

The Anoka soils in Stearns County have more fine and medium sand in the control section than is defined for the Anoka series. This difference, however, does not affect the use or behavior of the soils.

Anoka soils are commonly adjacent on the landscape to Dorset and Nymore soils and are in similar positions.

Typical pedon of Anoka loamy sand, 2 to 8 percent slopes, 2,550 feet north and 175 feet west of the southeast corner of sec. 27, T. 124 N., R. 28 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy sand, brown (10YR 5/3) dry; weak medium and coarse granular structure; very friable; slightly acid; clear wavy boundary.

E—9 to 14 inches; yellowish brown (10YR 5/4) loamy sand, pale brown (10YR 6/3) dry; weak medium and thick platy structure; very friable; slight acid; abrupt wavy boundary.

Bt1—14 to 21 inches; dark yellowish brown (10YR 4/4) fine sandy loam; medium subangular blocky structure; friable; medium acid; clear wavy boundary.

Bt2—21 to 30 inches; yellowish brown (10YR 5/6) very fine sandy loam; weak medium subangular blocky structure; friable; medium acid; clear wavy boundary.

Bt3—30 to 36 inches; yellowish brown (10YR 5/6) loamy sand; weak to moderate coarse subangular blocky structure; very friable; medium acid; clear wavy boundary.

E1—36 to 50 inches; yellowish brown (10YR 5/4) sand; massive to single grained; very friable; about 1 percent coarse fragments; slightly acid; gradual wavy boundary.

E2—50 to 62 inches; light yellowish brown (10YR 6/4) fine sand; massive to single grained; very friable; neutral; abrupt wavy boundary.

Bt—62 to 65 inches; brown (10YR 5/3) fine sandy loam; weak very fine subangular blocky structure; very friable; neutral; abrupt wavy boundary.

C—65 to 75 inches; yellowish brown (10YR 5/4) fine sand; massive to single grained; very friable to loose; neutral.

The solum ranges from 50 to 70 inches in thickness, and the depth to free carbonates is 60 inches or more. Coarse fragments of gravel size range from 0 to 5 percent in the solum.

The A horizon has value of 2 through 6 and chroma of 1 through 4. The texture is typically loamy sand, but the range includes fine sand, loamy fine sand, very fine sand, and loamy very fine sand. Reaction is medium acid to slightly acid.

The B horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 through 5, and chroma of 3 through 6. It is stratified fine sandy loam, loamy sand, loamy very fine sand, fine sand, very fine sand, and very fine sandy loam, and it has bands of sand, coarse sand, and sandy loam. It is medium acid to strongly acid.

The C horizon has hue of 10YR, value of 3 through 5, and chroma of 3 through 5. The texture is fine sand or very fine sand, but the range includes medium and coarse sand. The C horizon is slightly acid to neutral.

Becker Series

The Becker series consists of deep, moderately well drained and well drained soils. Permeability is moderately rapid in the upper part and rapid in the lower part. These soils are on high bottom lands along major rivers. The soils formed in loamy alluvium and sandy material. Slopes range from 0 to 2 percent.

Becker soils are adjacent on the landscape to Hubbard, Kalmarville, and Osakis soils and to Udifluvents, frequently flooded. Hubbard and Osakis soils are in higher positions on the landscape than Becker soils and are not subject to flooding. Kalmarville soils and Udifluvents, frequently flooded, are in lower positions on the flood plain.

Typical pedon of Becker fine sandy loam, 1,200 feet east and 1,790 feet south of the center of sec. 34, T. 126 N., R. 28 W.

A1—0 to 16 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; very friable; abundant very fine roots; neutral; clear wavy boundary.

A2—16 to 25 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; very friable; plentiful fine roots; neutral; clear wavy boundary.

A3—25 to 33 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; very friable; few fine and very fine roots; neutral; abrupt wavy boundary.

2Bw—33 to 38 inches; dark yellowish brown (10YR 4/4) loamy fine sand; weak medium subangular blocky structure; very friable; few very fine roots; neutral; clear wavy boundary.

2BC—38 to 47 inches; dark brown (10YR 4/3) loamy fine sand; weak coarse subangular blocky structure; very friable to loose; few very fine roots; neutral; clear wavy boundary.

2C—47 to 60 inches; yellowish brown (10YR 5/4) fine sand; massive parting to single grained; very friable to loose; neutral.

The solum is 30 to 48 inches thick. The depth to sand also ranges from 30 to 48 inches. Coarse fragments of gravel size generally are not present, but in some pedons they make up as much as 10 percent, by volume, of the solum. The solum is strongly acid to neutral. The mollic epipedon ranges from 24 to 40 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It typically is fine sandy loam, but in some places it is sandy loam, loam, or very fine sandy loam.

The B horizon has value and chroma of 3 or 4. It is loamy fine sand or fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It typically is fine sand, sand, or very fine sand, but the range includes coarse sand.

The C horizon, in some pedons, contains up to 20 percent of gravel-sized coarse fragments. Reaction is slightly acid to mildly alkaline.

Beltrami Series

The Beltrami series consists of deep, moderately well drained and somewhat poorly drained, moderately permeable soils on ground and end moraines. The soils formed in loamy glacial till. Slopes range from 1 to 3 percent.

Beltrami soils are adjacent on the landscape to Bluffton, Nebish, and Shooker soils. Bluffton and Shooker soils are in lower positions on the landscape. Nebish soils are in positions that are higher than those of Beltrami soils.

Typical pedon of Beltrami loam, 2,400 feet east and 1,310 feet north of the southwest corner of sec. 19, T. 126 N., R. 31 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam, light gray (10YR 6/1) dry; weak fine granular structure; friable; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

E1—6 to 10 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; moderate thin and medium platy structure parting to weak fine granular; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

E2—10 to 15 inches; grayish brown (10YR 5/2) loam, light gray (10YR 7/2) dry; moderate medium platy structure; friable; about 5 percent coarse fragments; slightly acid; abrupt wavy boundary.

Bt1—15 to 26 inches; light olive brown (2.5Y 5/4) loam; common medium distinct dark grayish brown (2.5Y 4/2) mottles; moderate medium subangular blocky structure; firm; few thin very dark gray (10YR 3/1) clay films on faces of peds and lining tubular pores; about 4 percent coarse fragments; slightly acid; clear wavy boundary.

Bt2—26 to 35 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct dark grayish brown (2.5Y 4/2) and common fine distinct brownish yellow (10YR 6/6) mottles; moderate medium angular blocky structure; firm; common moderately thick very

dark gray (10YR 3/1) clay films on faces of peds and few moderately thick very dark gray (10YR 3/1) clay films lining tubular pores; about 4 percent coarse fragments; neutral; clear wavy boundary.

C1—35 to 41 inches; light olive brown (2.5Y 5/4) loam; common medium distinct gray (N 5/0) and common fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; common thin very dark gray (10YR 3/1) clay films lining tubular pores; about 3 percent coarse fragments; fine irregularly shaped light gray (10YR 7/2) segregated lime filaments or threads; strongly effervescent; mildly alkaline; clear wavy boundary.

C2—41 to 60 inches; light olive brown (2.5Y 5/4) loam; common fine distinct gray (N 5/0) and common fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; fine irregularly shaped light gray (10YR 7/2) segregated lime filaments and threads; strongly effervescent; mildly alkaline.

The solum is 26 to 40 inches thick. The depth to free carbonates is also 26 to 40 inches. Coarse fragments of gravel size range from 2 to 8 percent in all horizons.

The A horizon has value of 2 through 5 and chroma of 1 or 2. Typically, it is loam, but the range includes fine sandy loam and sandy loam. Reaction is neutral or slightly acid.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. Some subhorizons have chroma of 2. There are mottles that have chroma of 2 or less in the upper 10 inches of the argillic horizon. The B horizon is loam, clay loam, or sandy clay loam. Clay films are thin to thick and few to many. Reaction ranges from slightly acid in the upper part to mildly alkaline in the lower part.

The C horizon has value of 5 or 6 and chroma of 2 through 4. It is loam or sandy loam and is mildly alkaline or moderately alkaline.

Biscay Series

The Biscay series consists of deep, poorly drained soils on outwash plains and stream terraces. Permeability is moderate in the upper part and rapid in the lower part. The soils formed in loamy material overlying calcareous sandy outwash. Slopes range from 0 to 2 percent.

Biscay soils are similar to Mayer and Regal soils and are adjacent on the landscape to Estherville, Mayer, and Osakis soils. Mayer soils have free carbonates in the upper part and are in positions on the landscape similar to those of Biscay soils. Regal soils have an upper loamy mantle that is less than 20 inches thick. Osakis and Estherville soils are in higher positions on the landscape.

Typical pedon of Biscay loam, 1,450 feet west and 2,110 feet south of the northeast corner of sec. 34, T. 123 N., R. 34 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; many roots; neutral; abrupt smooth boundary.

AB—8 to 16 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; many roots; about 3 percent coarse fragments; neutral; clear wavy boundary.

Bg—16 to 26 inches; gray (5Y 5/1) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; common roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

2C1—26 to 41 inches; olive gray (5Y 4/2) coarse sand; single grained; loose; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

2C2—41 to 60 inches; olive gray (5Y 4/2) gravelly coarse sand; single grained; loose; about 20 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates and to loamy sand or coarser textures range from 20 to 40 inches. The mollic epipedon is 16 to 24 inches thick.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. It is typically loam, but the range includes clay loam, sandy clay loam, and silty clay loam. Reaction ranges from slightly acid to mildly alkaline.

The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 through 3. Typically, it is loam, but in some pedons it is gravelly loam or gravelly sandy loam in the lower part.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is coarse sand, gravelly coarse sand, or sand. It is neutral to moderately alkaline. In some pedons, the upper few inches are neutral.

Blue Earth Series

The Blue Earth series consists of deep, very poorly drained, moderately permeable and moderately slowly permeable soils in pond or lake basins. The soils formed in calcareous coprogenous earth. Slopes range from 0 to 1 percent.

Blue Earth soils are similar to Muskego soils and commonly are adjacent on the landscape to Flom, Roliss, and Vallers soils. Muskego soils have 12 to 50 inches of sapric material overlying coprogenous earth. Flom, Roliss, and Vallers soils are in slightly higher positions on the landscape than Blue Earth soils.

Typical pedon of Blue Earth mucky silt loam, 1,660 feet north and 1,940 feet west of the southeast corner of sec. 30, T. 125 N., R. 34 W.

A—0 to 6 inches; black (10YR 2/1) mucky silt loam, black (10YR 2/1) dry; weak fine and medium granular structure; very friable; about 2 percent snail shell fragments; many roots; slight effervescence; mildly alkaline; clear wavy boundary.

C1—6 to 33 inches; very dark gray (10YR 3/1) mucky silt loam; weak thick platy structure parting to weak fine and medium subangular blocky; very friable; about 4 percent snail shell fragments; many roots; small amount of dark yellowish brown (10YR 4/4) decayed vegetative matter; slight effervescence; mildly alkaline; clear wavy boundary.

C2—33 to 38 inches; black (10YR 2/1) mucky silt loam; weak fine and medium subangular blocky structure parting to weak fine and medium granular; very friable; about 4 percent snail shell fragments; few roots; small amount of dark yellowish brown (10YR 4/4) decayed vegetative matter; slight effervescence; mildly alkaline; clear smooth boundary.

C3—38 to 60 inches; black (10YR 2/1) silt loam; few fine faint olive brown (2.5Y 4/4) mottles; massive; very friable; slight effervescence; mildly alkaline.

The thickness of the coprogenous earth and the depth to loamy glacial till range from 30 to 60 inches or more. In some pedons there is a thin layer of sapric material that is as much as 12 inches thick. The coprogenous earth contains between 2 and 15 percent of coarse fragments that are snail or clam shells.

The coprogenous earth has hue of 10YR through 5Y, value of 2 through 4, and chroma of 1 or 2. It is silt loam, silty clay loam, or the mucky analogs. Reaction of the surface layer is mildly alkaline or moderately alkaline.

Some pedons have a 2C horizon within a depth of 60 inches that has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, silt loam, or clay loam. It is mildly or moderately alkaline.

Blue Earth Variant

The Blue Earth Variant consists of deep, very poorly drained soils. Permeability is moderate in the upper part and rapid in the lower part. The soils are in postglacial lake basins and on outwash plains. They formed in coprogenous earth and loamy material overlying calcareous sandy and gravelly outwash. Slopes range from 0 to 2 percent.

Blue Earth Variant soils are similar to Blue Earth and Muskego soils and commonly are adjacent to Estherville, Osakis, and Regal soils. Blue Earth and Muskego soils and Blue Earth Variant soils are in similar positions on the landscape. Blue Earth and Muskego soils do not have sand and gravel in the underlying material. Estherville, Osakis, and Regal soils are in the adjacent upslope areas.

Typical pedon of Blue Earth Variant mucky silt loam, 1,452 feet east and 2,110 feet north of the southwest corner of sec. 35, T. 123 N., R. 34 W.

A—0 to 12 inches; black (10YR 2/1) mucky silt loam (coprogenous earth); weak medium granular structure; very friable; few snail shell fragments; many roots; strong effervescence; moderately alkaline; clear wavy boundary.

C1—12 to 18 inches; very dark gray (5Y 3/1) mucky silt loam (coprogenous earth); weak fine subangular blocky structure; very friable, firm when dry; few snail shell fragments; common roots; strong effervescence; moderately alkaline; clear wavy boundary.

C2—18 to 28 inches; black (N 2/0) mucky silt loam (coprogenous earth); massive; friable, firm when dry; few snail shell fragments; few roots; strong effervescence; moderately alkaline; clear wavy boundary.

2C—28 to 34 inches; very dark grayish brown (2.5Y 3/2) loam; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.

3C1—34 to 46 inches; light brownish gray (2.5Y 6/2) gravelly loamy coarse sand; massive to single grained; very friable; about 50 percent coarse fragments; slight effervescence; mildly alkaline; gradual broken boundary.

3C2—46 to 56 inches; olive gray (5Y 4/2) gravelly loamy coarse sand; massive to single grained; very friable; about 50 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

3C3—56 to 60 inches; yellowish brown (10YR 5/6) gravelly coarse sand; common medium distinct grayish brown (10YR 5/2) mottles; single grained; loose; about 20 percent coarse fragments; slight effervescence; mildly alkaline.

The coprogenous earth material is 16 to 40 inches thick. It has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has chroma of 0. It is silt loam, silty clay loam, or the mucky analogs. Reaction is mildly alkaline or moderately alkaline.

The 2C horizon is 0 to 6 inches thick. It has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It is loam, silt loam, silty clay loam, or clay loam. Reaction is mildly alkaline or moderately alkaline.

The 3C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 through 6, and chroma of 2 through 6. It is sand, loamy sand, coarse sand, loamy coarse sand, or the

gravelly analogs. Reaction is medium acid to moderately alkaline.

Bluffton Series

The Bluffton series consists of deep, very poorly drained, moderately slowly permeable soils in depressions on ground moraines. The soils formed in loamy alluvial sediment overlying calcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Bluffton soils are similar to Glencoe soils and commonly are adjacent to Flom, Roliss, and Vallers soils. Glencoe soils have a mollic epipedon that is more than 24 inches thick. Flom, Roliss, and Vallers soils are on the rim of depressions.

Typical pedon of Bluffton loam, 1,160 feet south and 1,420 feet east of the northwest corner of sec. 10, T. 125 N., R. 34 W.

A1—0 to 10 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine and medium subangular blocky structure; friable; common roots; slightly acid; clear smooth boundary.

A2—10 to 19 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; massive; friable; few roots; few fine dark yellowish brown (10YR 4/4) coatings in old root channels; slightly acid; clear wavy boundary.

Bg1—19 to 26 inches; dark grayish brown (5Y 4/2) clay loam; few medium distinct dark brown (7.5YR 4/4) and many fine faint dark grayish brown (2.5Y 4/2) mottles; weak medium blocky structure; friable; neutral; clear smooth boundary.

Bg2—26 to 33 inches; dark grayish brown (5Y 4/2) clay loam; common medium distinct dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

Cg1—33 to 39 inches; olive gray (5Y 5/2) loam; common medium distinct dark brown (7.5YR 4/4) mottles; massive; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Cg2—39 to 60 inches; olive gray (5Y 5/2) loam; many medium distinct dark brown (7.5YR 4/4) and yellowish brown (10YR 5/6) mottles; massive; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 15 to 40 inches. The mollic epipedon is 10 to 24 inches thick.

The A horizon has hue of 10YR or 2.5Y, value of 2, and chroma of 1 or 2, or it is neutral in hue and has value of 2 or 3 and chroma of 0. It is loam, silt loam, sandy loam, or sandy clay loam. Reaction is slightly acid or medium acid.

The B horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It is clay loam, loam, or sandy clay loam. It is moderately acid to neutral.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is loam or sandy clay loam. Reaction is mildly alkaline or moderately alkaline.

Brainerd Series

The Brainerd series consists of deep, moderately well drained, moderately slowly permeable soils on ground moraines and drumlin fields. The soils formed in noncalcareous, loamy glacial till. Slopes range from 1 to 4 percent.

Brainerd soils are similar to Alstad soils and are adjacent on the landscape to Flak, Nokay, and Prebish soils. Alstad soils have an argillic horizon and do not have fragic characteristics. Flak soils are in more sloping areas than Brainerd soils, and Nokay soils are in less sloping areas. Prebish soils are in depressions, potholes, and wet drainageways.

Typical pedon of Brainerd fine sandy loam, 1 to 4 percent slopes, 50 feet north and 1,350 feet east of the southwest corner of sec. 34, T. 124 N., R. 28 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) fine sandy loam, gray (10YR 5/1) dry; weak moderate granular structure; friable; about 2 percent coarse fragments; strongly acid; abrupt smooth boundary.

E1—6 to 10 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; common medium distinct dark brown (7.5YR 4/2 and 4/4) mottles; weak medium platy structure; friable; about 2 percent coarse fragments; strongly acid; clear wavy boundary.

E2—10 to 15 inches; dark grayish brown (10YR 4/2) and dark brown (10YR 4/3) fine sandy loam, light brownish gray (10YR 6/2) and pale brown (10YR 6/3) dry; common medium distinct dark brown (7.5YR 4/4) and dark reddish brown (5YR 3/2, 3/4) mottles; weak medium and thin platy structure; very friable; about 5 percent coarse fragments; many vesicular pores; strongly acid; clear smooth boundary.

Bw1—15 to 22 inches; dark brown (7.5YR 4/4) sandy loam; common medium and coarse faint dark grayish brown and dark brown (7.5YR 4/1, 3/2, and 4/2) mottles; weak medium subangular blocky structure; friable; thin patchy clay films on faces of peds and in pebble sockets; about 10 percent coarse fragments; medium acid; clear wavy boundary.

Bw2—22 to 27 inches; brown (7.5YR 5/3) fine sandy loam; common medium and coarse faint dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure parting to weak thick platy; friable; thin patchy clay films on faces of peds and pebbles; about 10 percent coarse fragments; medium acid; clear wavy boundary.

Bx1—27 to 43 inches; dark brown (7.5YR 4/4) fine sandy loam; common medium distinct brown (7.5YR 5/3) and grayish brown (10YR 5/2) mottles; moderate thick platy structure; firm; about 10 percent coarse fragments; medium acid; gradual wavy boundary.

Bx2—43 to 55 inches; dark brown (7.5YR 4/4) fine sandy loam; few coarse distinct grayish brown (7.5YR 5/2) and dark reddish brown (5YR 3/4) mottles; weak thick platy structure; firm; about 10 percent coarse fragments; slightly acid; diffuse wavy boundary.

Cx—55 to 60 inches; dark brown (7.5YR 4/4) sandy loam; few medium distinct grayish brown (10YR 5/2) and yellowish red (5YR 5/6) mottles; weak medium platy structure; firm; about 10 percent coarse fragments; slightly acid.

The solum is 40 to 60 inches thick. The depth to the fragipan ranges from 18 to 30 inches. Coarse fragments of gravel size make up 5 to 20 percent of the volume in the solum and the C horizon.

The A horizon has hue of 7.5YR or 10YR, value of 2 through 5, and chroma of 1 through 3. In some pedons it has distinct or prominent mottles. The texture is sandy loam or fine sandy loam, and the reaction is strongly acid to very strongly acid.

The B horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It has distinct or prominent mottles. Texture is sandy loam or fine sandy loam, and reaction is very strongly acid to medium acid.

The Bx and Cx horizons have value of 4 or 5 and chroma of 3 through 5. Mottles are faint to prominent and range from 5YR to 10YR in hue. The Bx and Cx horizons are neutral to medium acid.

Cathro Series

The Cathro series consists of deep, very poorly drained soils. Permeability is moderately slow to moderately rapid in the upper part and moderately slow and moderate in the lower part. The soils are in depressions. They formed in highly decomposed, herbaceous organic material overlying loamy glacial till. Slopes range from 0 to 2 percent.

Cathro soils are similar to Markey soils and commonly are adjacent to Flom, Glencoe, Roliss, Seelyeville, and Vallers soils. Flom, Roliss, and Vallers soils are on the rim of the depressions. Markey soils have a sandy and gravelly 2C horizon. Seelyeville soils have 51 inches or more of sapric material above the 2C horizon. Glencoe soils and Cathro soils are in similar positions on the landscape.

Typical pedon of Cathro muck, 20 feet north and 2,480 feet east of the southwest corner of sec. 22, T. 125 N., R. 34 W.

Oa1—0 to 14 inches; black (10YR 2/1) broken face and rubbed sapric material; less than 15 percent fibers, less than 5 percent rubbed; weak thin platy structure parting to weak medium subangular blocky; nonsticky; primarily herbaceous fibers; slightly acid; clear wavy boundary.

Oa2—14 to 40 inches; black (10YR 2/1) broken face and rubbed sapric material; about 5 percent fiber, about 1 percent rubbed; weak medium subangular blocky structure parting to weak fine and medium granular; nonsticky; primarily herbaceous fibers; slightly acid; clear smooth boundary.

2Cg1—40 to 43 inches; grayish brown (2.5Y 5/2) silt loam; common fine distinct yellowish brown (10YR 5/4) mottles; massive; friable; few fine distinct yellowish red (5YR 4/6) coatings in old root channels; about 2 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

2Cg2—43 to 60 inches; olive gray (5Y 4/2) loam; common medium distinct olive brown (2.5Y 4/4) mottles; massive; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The depth to the 2C horizon ranges from 16 to 51 inches. There are no free carbonates in the organic material.

The organic part of the control section has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. Reaction is medium acid to neutral. The surface tier is hemic or sapric material. The subsurface tier is sapric material and includes less than 10 inches of hemic material.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It is loam, silt loam, or clay loam. Reaction is mildly alkaline or moderately alkaline.

Chetek Series

The Chetek series consists of deep, somewhat excessively drained soils. Permeability is moderately rapid in the upper part and rapid in the lower part. The soils are on outwash plains, stream terraces, and ground moraines. They formed in a thin loamy mantle overlying noncalcareous gravelly and sandy material. Slopes range from 1 to 6 percent.

Chetek soils are adjacent to Flak, Mahtomedi, and Nokay soils. Flak and Mahtomedi soils are in positions on the landscape similar to those of Chetek soils. Nokay soils are in lower positions.

Typical pedon of Chetek sandy loam, 1 to 6 percent slopes, 110 feet north and 1,030 feet west of the southwest corner of sec. 19, T. 126 N., R. 28 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium

and coarse subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; abrupt wavy boundary.

E—6 to 13 inches; brown (10YR 4/3) sandy loam, pale brown (10YR 6/3) dry; weak medium platy structure; friable; about 10 percent coarse fragments; medium acid; clear wavy boundary.

Bt—13 to 23 inches; dark reddish brown (5YR 3/4) sandy loam; weak medium subangular blocky structure; friable; dark reddish brown (5YR 2/2) patchy clay films on faces of peds and clay bridges between sand grains; about 14 percent coarse fragments; few cobbles; medium acid; clear wavy boundary.

2C1—23 to 29 inches; reddish brown (7.5YR 4/4) gravelly loamy coarse sand; massive; very friable; about 20 percent coarse fragments; medium acid; clear wavy boundary.

2C2—29 to 60 inches; reddish brown (7.5YR 5/4) gravelly coarse sand; single grained; loose; about 20 to 35 percent coarse fragments; slightly acid.

The solum is 12 to 24 inches thick. Typically, free carbonates are at a depth of more than 60 inches, but in some places they are at a depth of 40 to 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. Typically, it is sandy loam, but the range includes loam. Reaction is slightly acid or medium acid.

The B horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 3 or 4. It is sandy loam or loam. Reaction is slightly acid to strongly acid.

The C horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 4 through 6. It is gravelly and sandy. Coarse fragments of gravel size make up 15 to 35 percent, by volume. The C horizon is slightly acid to strongly acid.

Cordova Series

The Cordova series consists of deep, poorly drained, moderately slowly permeable soils on ground moraines. The soils formed in loamy glacial till. Slopes range from 0 to 2 percent.

Cordova soils are similar to Flom soils and commonly are adjacent on the landscape to Glencoe, Gonvick, and Marcellon soils. Flom soils do not have an argillic horizon. Glencoe soils are in lower positions on the landscape. Gonvick and Marcellon soils are in higher positions on the landscape.

Typical pedon of Cordova loam, 700 feet west and 1,140 feet north of the center of sec. 12, T. 126 N., R. 34 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; common roots; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

AB—10 to 13 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak thin platy structure parting to weak fine and medium subangular blocky; friable; few roots; about 2 percent coarse fragments; medium acid; gradual wavy boundary.

Btg1—13 to 22 inches; dark grayish brown (2.5Y 4/2) clay loam; common fine distinct yellowish brown (10YR 5/4) mottles; moderate fine and medium subangular blocky structure parting to weak fine granular; firm; few patchy fine very dark brown (10YR 2/2) clay films on faces of peds; few roots; about 3 percent coarse fragments; medium acid; clear wavy boundary.

Btg2—22 to 30 inches; olive gray (5Y 5/2) clay loam; common fine distinct yellowish brown (10YR 5/4) mottles; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; many nearly continuous very dark grayish brown (10YR 3/2) clay films on faces of peds; few roots; about 4 percent coarse fragments; slightly acid; clear wavy boundary.

Btg3—30 to 36 inches; olive gray (5Y 5/2) loam; common fine distinct light olive brown (2.5Y 5/4) and few fine faint yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure parting to weak fine granular; friable; common fine patchy very dark grayish brown (10YR 3/2) clay films on faces of peds and lining pores; few roots; about 4 percent coarse fragments; slightly acid; clear wavy boundary.

BC—36 to 41 inches; olive gray (5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure parting to weak fine granular; friable; few fine very dark grayish brown (10YR 3/2) clay films in old root channels; few roots; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C—41 to 60 inches; olive (5Y 5/3) loam; common medium distinct dark grayish brown (2.5Y 4/2) and few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; very few very dark grayish brown (10YR 3/2) clay films in old root channels in the upper part; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The solum is 24 to 46 inches thick. The depth to free carbonates also ranges from 24 to 46 inches. The mollic epipedon is 10 to 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 1, or it is neutral in hue and has value of 2 and reaction is neutral or slightly acid. Some pedons contain a thin discontinuous E horizon.

The upper part of the B horizon has hue of 10YR, 2.5Y, or 5Y, and value of 3 through 5. If the hue is 10YR, chroma is 1; if the hue is 2.5Y or 5Y, chroma is 1 or 2.

The B horizon has distinct or prominent mottles in some part. It is loam, clay loam, or silty clay loam. It is medium acid to mildly alkaline.

The C horizon has hue of 5Y or 2.5Y. It is mildly alkaline or moderately alkaline.

Coriff Series

The Coriff series consists of deep, poorly drained, moderately permeable soils on water-worked ground moraines and in glacial lake basins. The soils formed in a loamy and sandy mantle overlying calcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Coriff soils are similar to Roliss soils and commonly are adjacent to Lowlein and Corunna soils. Roliss soils are fine-loamy. Lowlein soils are in higher positions on the landscape, and Corunna soils are in positions similar to those of Coriff soils.

Typical pedon of Coriff loam, 2,400 feet north and 1,160 feet east of the southwest corner of sec. 9, T. 125 N., R. 34 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; common roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

AB—9 to 18 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; few roots; about 1 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Bg1—18 to 24 inches; olive gray (5Y 5/2) sandy loam; few fine distinct olive brown (2.5Y 4/4) mottles; weak fine subangular blocky structure; friable; few roots; about 10 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Bg2—24 to 34 inches; olive gray (5Y 5/2) loamy sand; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine granular structure; friable; about 10 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.

2Cg—34 to 60 inches; olive gray (5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) and common medium distinct olive brown (2.5Y 4/4) mottles; massive; friable; few fine prominent yellowish red (5YR 4/6) masses of iron; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The solum is 24 to 40 inches thick. The mollic epipedon is 12 to 22 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or sandy loam. Reaction is mildly alkaline or moderately alkaline.

The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. Typically, it is stratified and is sandy loam in the upper part and loamy sand, sand, or fine sand in the lower part. Reaction is mildly alkaline or moderately alkaline.

The 2C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 through 4. Reaction is mildly alkaline or moderately alkaline.

Corunna Series

The Corunna series consists of deep, poorly drained, moderately slowly permeable soils on water-worked ground moraines and in glacial lake basins. The soils formed in a stratified upper mantle overlying calcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Corunna soils are similar to Flom soils and commonly are adjacent to Coriff and Lowlein soils. Flom soils are fine-loamy. Coriff soils and Corunna soils are in similar positions on the landscape; Lowlein soils are in higher positions.

Typical pedon of Corunna loam, 2,380 feet east and 700 feet south of the northwest corner of sec. 8, T. 125 N., R. 33 W.

Ap—0 to 8 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine and medium subangular blocky structure; friable; common roots; neutral; abrupt smooth boundary.

AB—8 to 19 inches; very dark gray (10YR 3/1) sandy loam, grayish brown (10YR 4/1) dry; weak fine subangular blocky structure; friable; few roots; neutral; clear smooth boundary.

Bg1—19 to 25 inches; olive gray (5Y 5/2) sandy loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; clear wavy boundary.

Bg2—25 to 32 inches; olive gray (5Y 5/2) loamy sand; common medium distinct olive brown (2.5Y 4/4) mottles; single grained; loose; about 10 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

2Cg—32 to 60 inches; olive gray (5Y 5/2) loam; common medium distinct dark yellowish brown (10YR 3/4) mottles; massive; friable; about 4 percent coarse fragments; few fine irregularly shaped lime filaments; strong effervescence; mildly alkaline.

The solum and the upper mantle are 24 to 40 inches thick. The mollic epipedon is 10 to 24 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has chroma of 0. It is loam or sandy loam.

The B horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is sandy loam in the upper part and loamy sand, sand, or fine sand in the lower part. Reaction is slightly acid to mildly alkaline.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 2 through 4. Reaction is mildly alkaline or moderately alkaline.

Cushing Series

The Cushing series consists of deep, well drained, moderately slowly permeable soils on ground and end moraines. The soils formed in noncalcareous, loamy glacial till. Slopes range from 2 to 40 percent.

Cushing soils are adjacent to Alstad, DeMontreville, Nokay, Prebish, and Jewett soils. DeMontreville and Jewett soils are in positions on the landscape similar to those of Cushing soils. Alstad soils are in less sloping areas. Prebish and Nokay soils are in depressions and drainageways.

Typical pedon of Cushing sandy loam, 8 to 15 percent slopes, 100 feet west and 2,350 feet south of the northeast corner of sec. 1, T. 124 N., R. 30 W.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) sandy loam, light brownish gray (10YR 6/2) dry; weak medium granular structure; very friable; about 10 percent coarse fragments; slightly acid; abrupt wavy boundary.

E1—5 to 8 inches; dark brown (10YR 4/3) sandy loam, pale brown (10YR 6/3) dry; weak medium platy structure; very friable; about 10 percent coarse fragments; medium acid; abrupt wavy boundary.

E2—8 to 12 inches; yellowish brown (10YR 5/4) sandy loam, very pale brown (10YR 7/3) dry; weak to moderate medium platy structure; very friable; about 10 percent coarse fragments; medium acid; clear irregular boundary.

B/E—12 to 19 inches; dark yellowish brown (10YR 4/4) sandy loam (B2), yellowish brown (10YR 5/4) sandy loam (E) between peds; moderate fine and medium subangular blocky structure; friable; about 10 percent coarse fragments; medium acid; clear wavy boundary.

Bt1—19 to 24 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate medium and fine subangular blocky structure; friable; continuous thin dark reddish brown (5YR 3/4) clay films on faces of peds; about 10 percent coarse fragments; strongly acid; clear wavy boundary.

Bt2—24 to 31 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate medium platy structure; friable; continuous thin dark reddish brown (5YR 3/4) clay films on faces of peds; about 10 percent coarse fragments; strongly acid; clear wavy boundary.

C—31 to 60 inches; dark brown (7.5YR 4/4) sandy loam; massive; very friable; about 10 percent coarse fragments; medium acid.

The solum is 24 to 48 inches thick. There are no free carbonates in the control section, nor are there any, in most pedons, within a depth of 60 inches or more. In some parts of the solum, gravel-sized coarse fragments range from 2 to 20 percent, by volume. The fragments are as large as 3 inches. In some places, there are cobbles and a few boulders.

The A horizon has value of 2 through 5 and chroma of 1 through 4. It commonly is sandy loam or fine sandy loam, but the range includes loamy sand. Reaction is neutral to strongly acid.

The B horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 through 6. It typically is sandy clay loam or loam, but the range includes sandy loam, fine sandy loam, and coarse sandy loam. Reaction is slightly acid to strongly acid.

The C horizon has hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 4 through 6. Reaction is medium acid to neutral.

Cylinder Series

The Cylinder series consists of deep, somewhat poorly drained soils. Permeability is moderate in the upper part and very rapid in the underlying material. The soils are on outwash plains and on stream terraces. They formed in glacial outwash consisting of a loamy mantle underlain by sandy material. Slopes range from 0 to 2 percent.

Cylinder soils commonly are adjacent to Biscay, Dakota, Estherville, and Fairhaven soils. Biscay soils are lower on the landscape than Cylinder soils, and Dakota, Fairhaven, and Estherville soils are higher.

Typical pedon of Cylinder loam, 100 feet east and 2,420 feet south of the northwest corner of sec. 16, T. 126 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; many roots; neutral; clear smooth boundary.

AB—9 to 14 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; many roots; neutral; clear wavy boundary.

Bw1—14 to 19 inches; dark grayish brown (10YR 4/2) loam; dark brown (10YR 3/3) coats on peds; weak fine and medium subangular blocky structure; friable; few roots; neutral; clear wavy boundary.

Bw2—19 to 26 inches; dark grayish brown (10YR 4/2) loam; few fine faint grayish brown (10YR 5/2) and common medium faint dark yellowish brown (10YR 4/4) mottles; weak fine and medium subangular blocky structure; friable; few roots; about 2 percent coarse fragments; neutral; abrupt wavy boundary.

2BC—26 to 31 inches; dark brown (10YR 4/3) and grayish brown (10YR 5/2) loamy coarse sand; single grained; loose; 5 to 10 percent coarse fragments; neutral; clear wavy boundary.

2C—31 to 60 inches; dark brown (10YR 4/3) and grayish brown (10YR 5/2) gravelly coarse sand; single

grained; loose; 15 to 20 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 24 to 48 inches in thickness, and depth to sand and gravel is 24 to 36 inches. The mollic epipedon is 10 to 24 inches thick. The upper mantle is loamy; it is 18 to 30 percent clay. The solum is neutral or slightly acid.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The A horizon is loam or clay loam.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is loam or light clay loam. Mottles are few to common. In some pedons there is a B3 transition layer; it is loam to gravelly sand.

The C horizon has hue of 10YR or 2.5Y, value of 3 through 6, and chroma of 2 through 4. Colors are commonly variegated. The C horizon is sand, coarse sand, gravelly coarse sand, or stratified sand and gravel. Coarse fragments of gravel size make up 5 to 30 percent of the horizon. Reaction is mildly alkaline or moderately alkaline.

Dakota Series

The Dakota series consists of deep, well drained soils. Permeability is moderate in the upper part and rapid in the lower part. The soils are on outwash plains, stream terraces, and valley trains. They formed in glacial outwash consisting of a loamy mantle over sandy material. Slopes range from 0 to 6 percent.

Dakota soils are similar to Ridgeport soils and commonly are adjacent on the landscape to Biscay, Cylinder, Estherville, and Fairhaven soils. Ridgeport soils formed in sandier material and do not have an argillic horizon. Biscay and Cylinder soils are in lower positions on the landscape. Estherville and Fairhaven soils are in positions similar to those of Dakota soils.

Typical pedon of Dakota loam, 2 to 6 percent slopes, 1,650 feet west and 75 feet north of the southeast corner of sec. 13, T. 122 N., R. 29 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; strongly acid; clear wavy boundary.

AB—9 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; strongly acid; clear wavy boundary.

Bt1—14 to 22 inches; dark yellowish brown (10YR 4/4) silt loam; moderate fine and medium subangular blocky structure; friable; many moderately thick very dark grayish brown (10YR 3/2) clay films on faces of peds and in tubular pores; about 1 percent coarse fragments; strongly acid; clear wavy boundary.

Bt2—22 to 27 inches; yellowish brown (10YR 5/4) silt loam; moderate medium subangular blocky structure; friable; common thin dark brown (10YR 3/3) clay films on faces of peds and in tubular pores; about 2 percent coarse fragments; strongly acid; clear wavy boundary.

2Bt3—27 to 31 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; friable; sand grains bridged by clay in many places; about 4 percent coarse fragments; strongly acid; clear wavy boundary.

2BC—31 to 45 inches; yellowish brown (10YR 5/4) coarse sand; single grained; loose; about 10 percent coarse fragments; medium acid; clear wavy boundary.

2C—45 to 60 inches; light yellowish brown (10YR 6/4) gravelly coarse sand; single grained; loose; about 15 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum is 28 to 45 inches. The depth to free carbonates is 40 to 80 inches. The thickness of the loamy mantle and the depth to contrasting material range from 20 to 40 inches. The mollic epipedon is 10 to 18 inches thick. Coarse fragments of gravel size make up 0 to 5 percent of the loamy mantle and 5 to 25 percent of the 2C horizon.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It is dominantly loam, but the range includes fine sandy loam and sandy loam. It is strongly acid to slightly acid. In some pedons there is an AB horizon.

The B horizon has hue of 7.5YR or 10YR and value and chroma of 3 through 5. It is dominantly loam, but the range includes sandy clay loam, silt loam, and sandy loam. The coarser textures are only in the lower part. The B horizon is strongly acid through slightly acid.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 3 through 5. It is sand or coarse sand, and it has gravelly strata in some places. It is medium acid through mildly alkaline.

Dalbo Series

The Dalbo soils consists of deep, moderately well drained, slowly permeable and moderately slowly permeable soils that formed in lacustrine sediments surrounding iceblock depressions in outwash plains. Slopes range from 2 to 8 percent.

The soils in the survey area have less clay in the subsoil than is defined for the Dalbo series; also, they do not have the low-chroma mottles that are definitive for the series. These differences, however, do not affect the use or behavior of the soils.

Dalbo soils commonly are adjacent to Dickman and Hubbard soils; both of these soils are in higher positions on the landscape.

Typical pedon of Dalbo loam, 2 to 8 percent slopes, 840 feet east and 2,240 feet south of the northwest corner of sec. 17, T. 123 N., R. 27 W.

A1—0 to 3 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; medium granular structure; very friable; mildly alkaline; abrupt smooth boundary.

AE—3 to 6 inches; very dark grayish brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; very friable; slightly acid; clear wavy boundary.

B/E—6 to 14 inches; dark brown (10YR 4/3) very fine sandy loam (B); thick very pale brown (10YR 7/3, dry) and pale brown (10YR 6/3, dry) very fine sandy loam coatings (E) along faces of peds; moderate fine angular blocky structure; friable; neutral; gradual wavy boundary.

Bt1—14 to 24 inches; dark yellowish brown (10YR 4/4) loam; moderate fine angular and subangular blocky structure; friable; few thin brown (10YR 4/3) clay films on faces of peds; neutral; gradual wavy boundary.

Bt2—24 to 30 inches; dark yellowish brown (10YR 4/4) clay loam; strong fine angular blocky structure; friable; continuous moderately thick dark brown (10YR 3/3) and dark yellowish brown (10YR 3/4) clay films on faces of peds; many distinct very dark brown (10YR 2/2) clay films in pores; neutral; gradual wavy boundary.

2C—30 to 60 inches; grayish brown (2.5Y 5/2) clay; common fine distinct yellow (10YR 7/6, 7/8) mottles; moderate very fine angular blocky structure; friable; many distinct very dark brown (10YR 2/2) clay films in pores; few hard lime concretions; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 40 inches. Coarse fragments are absent in the solum and in the upper part of the C horizon.

The A horizon has value of 2 through 5 and chroma of 1 or 2. It is fine sandy loam, very fine sandy loam, loam, or silt loam. Reaction ranges from medium acid to mildly alkaline.

The B horizon has value of 4 or 5 and chroma of 3 or 4. It typically is very fine sandy loam, loam, silt loam, silty clay loam, or clay loam. Reaction ranges from strongly acid to neutral.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 through 4. It is typically silt loam, silty clay loam, silty clay, or clay. Reaction ranges from mildly alkaline to moderately alkaline.

Darfur Series

The Darfur series consists of deep, poorly drained, moderately rapidly permeable soils that formed in stratified loamy and sandy outwash. The slopes range from 0 to 2 percent.

Darfur soils are similar to Isan soils and commonly are adjacent to Dassel, Litchfield, and Ridgeport soils. Isan soils are not stratified and do not have fine textural bands in the profile. Also, they are leached more deeply than Darfur soils. Dassel soils are in depressions and drainageways. Litchfield and Ridgeport soils are in higher positions on the landscape.

Typical pedon of Darfur coarse sandy loam, 130 feet west and 20 feet north of the southeast corner of sec. 19, T. 125 N., R. 28 W.

A—0 to 11 inches; black (10YR 2/1) coarse sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; slightly acid; clear smooth boundary.

AB—11 to 17 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; few fine faint dark brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.

Bg1—17 to 24 inches; dark grayish brown (10YR 4/2) loamy sand; common fine faint dark brown (10YR 4/3) mottles; weak thin and medium platy structure; very friable; slightly acid; clear wavy boundary.

Bg2—24 to 30 inches; grayish brown (10YR 5/2) sandy loam; common medium faint yellowish brown (10YR 5/6) mottles; weak thin platy structure; very friable; slightly acid; clear wavy boundary.

Cg—30 to 60 inches; stratified, grayish brown (2.5Y 5/2) and olive gray (5Y 5/2) loamy sand, sandy loam, and sand; common medium distinct yellowish brown (10YR 5/6) mottles; massive; very friable; about 1 percent coarse fragments; neutral.

The solum ranges from 24 to 40 inches in thickness. Free carbonates are at a depth of more than 40 inches. In some places, the solum does not contain coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam, coarse sandy loam, loam, or sandy loam. Reaction is slightly acid to neutral.

The B horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 1 or 2. It is fine sandy loam, loam, or loamy sand in the upper part and loamy fine sand or loamy sand in the lower part. Some pedons have strata of finer textured material. Reaction is slightly acid to mildly alkaline.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 or 6, and chroma of 1 or 2. Mottles are present in some part of the horizon. Typically, the C horizon is sand, loamy sand, or sandy loam, and it commonly is stratified. Some pedons have strata of finer textured material. Reaction ranges from neutral to moderately alkaline.

Dassel Series

The Dassel series consists of deep, poorly drained and very poorly drained soils. Permeability is moderately rapid in the upper part and rapid in the lower part. The

soils are on nearly level glacial deltas, outwash plains, and valley trains. They formed in stratified loamy sediment overlying sandy sediment. Slopes range from 0 to 1 percent.

Dassel soils are adjacent on the landscape to Darfur, Estherville, and Litchfield soils. Darfur soils are in wet, level areas and are in somewhat higher positions on the landscape than Dassel soils. Estherville and Litchfield soils are in higher positions.

Typical pedon of Dassel sandy loam, 75 feet east and 730 feet south of the northwest corner of sec. 30, T. 125 N., R. 28 W.

Ap—0 to 8 inches; black (N 2/0) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

AB—8 to 11 inches; black (N 2/0) and very dark grayish brown (10YR 3/2) sandy loam, light olive brown (2.5Y 5/4) and dark gray (10YR 4/1) dry; weak medium and coarse subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear irregular boundary.

Bg1—11 to 16 inches; olive gray (5Y 4/2) sandy loam; common coarse prominent yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; friable; about 2 percent coarse fragments; very slightly acid; clear irregular boundary.

Bg2—16 to 23 inches; grayish brown (2.5Y 5/2) coarse sandy loam; common coarse prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; about 2 percent coarse fragments; slightly acid; abrupt wavy boundary.

Bg3—23 to 28 inches; olive gray (5Y 5/2) fine sandy loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; abrupt wavy boundary.

C1—28 to 51 inches; light olive brown (2.5Y 5/4) and olive gray (5Y 5/2) loamy sand; massive; loose; about 14 percent coarse fragments; slightly acid; clear wavy boundary.

C2—51 to 60 inches; light olive brown (2.5Y 5/6) gravelly coarse sand; single grained; loose; about 18 percent coarse fragments; slightly acid.

The solum ranges from 20 to 50 inches in thickness. Free carbonates are typically at a depth of 18 to 70 inches. Coarse fragments of gravel size range from 0 to 5 percent in the solum.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3, or it is neutral in hue and has chroma of 0. It is sandy loam, fine sandy loam, or loam. In places, it contains enough organic matter to be mucky. Reaction is medium acid through neutral.

The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It commonly has faint to prominent olive mottles in most subhorizons. It is fine sandy loam, coarse sandy loam, sandy loam, loamy sand, or loam. Reaction is medium acid through neutral.

The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 through 6. Reaction is acid through mildly alkaline. Some pedons have discontinuous gravelly strata.

DeMontreville Series

The DeMontreville series consists of deep, well drained soils. Permeability is rapid in the sandy mantle and moderately slow in the underlying material. The soils are on ground and end moraines. They formed in a sandy mantle over noncalcareous, loamy glacial till. Slopes range from 2 to 25 percent.

DeMontreville soils are adjacent on the landscape to Alstad, Cushing, Nokay, and Prebish soils. Cushing soils are in positions similar to those of DeMontreville soils. Alstad soils are in lower positions and are less sloping. Nokay and Prebish soils form a complex that is in depressions and drainageways.

Typical pedon of DeMontreville loamy sand, 8 to 15 percent slopes, 2,100 feet west and 600 feet south of the center of sec. 3, T. 124 N., R. 30 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; about 5 percent coarse fragments; medium acid; clear wavy boundary.

E1—7 to 14 inches; dark brown (10YR 4/3) loamy sand, pinkish gray (10YR 6/2) dry; weak medium platy structure parting to weak fine subangular blocky; loose; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

E2—14 to 28 inches; dark brown (7.5YR 4/4) coarse sand; single grained; very friable; about 10 percent coarse fragments; medium acid; clear wavy boundary.

2Bt1—28 to 36 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; common thin reddish brown (5YR 4/3) clay films on faces of peds; about 10 percent coarse fragments; medium acid; clear wavy boundary.

2Bt2—36 to 45 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; firm; common moderately thick reddish brown (5YR 4/3) clay films on faces of peds; about 8 percent coarse fragments; medium acid; clear wavy boundary.

2C—45 to 60 inches; dark brown (7.5YR 4/4) sandy loam; weak fine subangular blocky structure; friable; about 10 percent coarse fragments; medium acid.

The solum ranges from 30 to 50 inches in thickness. Depth to the glacial till is 20 to 40 inches. There commonly are no free carbonates to a depth of 60 inches or more. Coarse fragments of gravel size make up 0 to 10 percent of the A and B horizons and 8 to 20 percent of the contrasting underlying material.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 through 3. Typically it is loamy sand, but the range includes loamy fine sand, sand, and fine sand. Reaction is medium acid through neutral.

The E horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 through 6. It is loamy sand, loamy coarse sand, coarse sand, sand, fine sand, or loamy fine sand. There is a transition horizon in some pedons. Reaction ranges from medium acid through neutral.

The 2B horizon has hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 3 through 6. It generally is sandy loam, but the range includes sandy clay loam, loam, and fine sandy loam. Reaction is medium or slightly acid. The Bt horizon has few to many clay films.

The 2C horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 4 through 6. It is sandy loam or coarse sandy loam, but the range includes loamy coarse sand. The 2C horizon is medium acid through neutral.

Dickman Series

The Dickman series consists of deep, well drained soils. The soils have moderately rapid permeability in the upper part and rapid permeability in the underlying material. They are on outwash plains and stream terraces. They formed in loamy material 12 to 20 inches thick and in the underlying sandy outwash. Slopes range from 0 to 6 percent.

Dickman soils are similar to Estherville soils and commonly are adjacent on the landscape to Dickinson, Duelm, and Hubbard soils. Dickinson soils have a loamy mantle more than 20 inches thick. They and Dickman soils are in similar positions. Estherville soils have free carbonates at a depth of 15 to 24 inches. Hubbard soils have coarser textures below a depth of 10 inches than Dickman soils, and they are in similar positions. Duelm soils are downslope.

Typical pedon of Dickman sandy loam, 0 to 2 percent slopes, 2,260 feet south and 2,100 feet west of the northeast corner of sec. 32, T. 127 N., R. 34 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; very friable; common roots; slightly acid; abrupt smooth boundary.

AB—9 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; very friable; few roots; slightly acid; clear wavy boundary.

Bw—14 to 19 inches; dark yellowish brown (10YR 3/4) sandy loam; weak fine and medium subangular blocky structure; very friable; few roots; about 2 percent coarse fragments; neutral; clear wavy boundary.

2BC—19 to 34 inches; dark yellowish brown (10YR 4/4) sand; single grained; loose; about 2 percent coarse fragments; neutral; clear wavy boundary.

2C—34 to 60 inches; dark yellowish brown (10YR 5/4) coarse sand; single grained; loose; about 5 percent coarse fragments; neutral.

The solum ranges from 30 to 50 inches in thickness. The mollic epipedon is 10 to 16 inches thick. The depth to loamy sand or coarser textures ranges from 12 to 20 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is typically sandy loam, but it ranges to coarse sandy loam and fine sandy loam. Reaction is medium or slightly acid.

The B horizon has value of 3 through 5 and chroma of 3 or 4. It typically is sandy loam, coarse sandy loam, fine sandy loam, or loamy sand in the upper part and fine sand, coarse sand, or sand in the lower part. Reaction is medium acid to neutral.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It is sand, fine sand, or coarse sand. Reaction is slightly acid to mildly alkaline.

Doland Series

The Doland series consists of deep, well drained, moderately permeable soils on silt-mantled ground and end moraines. The soils formed in a silty mantle overlying calcareous, loamy glacial till. Slopes range from 1 to 6 percent.

Doland soils are similar to Ves soils and commonly are adjacent to Flom, Tara, and Ves soils. Flom soils are in lower positions on the landscape, and Tara soils are downslope. Ves soils do not have a silty mantle. They and the Doland soils are in similar positions on the landscape.

Typical pedon of Doland silt loam, 1 to 6 percent slopes, 925 feet south and 660 feet west of the center of sec. 6, T. 126 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

AB—9 to 13 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

Bw—13 to 24 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine and medium subangular blocky structure; very friable; neutral; abrupt wavy boundary.

2C1—24 to 39 inches; olive brown (2.5Y 4/4) loam; few fine distinct light olive brown (2.5Y 5/6) mottles; platelike structure; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

2C2—39 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine faint light olive brown (2.5Y 5/6) and gray (10YR 5/1) mottles; platelike structure; friable; few fine distinct strong brown (7.5YR 5/6) masses of iron; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The solum is 20 to 28 inches thick. The thickness is the same as the depth to free carbonates. The mollic epipedon is 9 to 16 inches thick.

The A horizon has value of 2 or 3. Reaction is neutral or slightly acid.

The B horizon has value of 3 through 5 and chroma of 2 through 4. Reaction is neutral or slightly acid. In some places, there is a thin pebble band at the contact of the silty mantle and the loamy glacial till.

The 2C horizon has value of 4 or 5 and chroma of 2 through 4. It is neutral to moderately alkaline. There is a concentration of lime in the upper part in some pedons.

Dorset Series

The Dorset series consists of deep, well drained soils. Permeability is moderately rapid in the upper part and rapid in the lower part. The soils formed in a loamy mantle over sandy sediment on outwash plains, valley trains, and kames. Slopes range from 2 to 25 percent.

Dorset soils are adjacent on the landscape to Biscay, Cylinder, and Dakota soils. Biscay and Cylinder soils are in lower positions than Dorset soils, and Dakota soils are in less sloping areas.

Typical pedon of Dorset sandy loam, 2 to 8 percent slopes, 1,520 feet east and 740 feet south of the northwest corner of sec. 36, T. 123 N., R. 28 W.

A—0 to 7 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine and medium granular structure; friable; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

E—7 to 10 inches; dark brown (10YR 4/3) sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

Bt1—10 to 14 inches; dark brown (7.5YR 4/4) sandy loam; moderate fine and medium subangular structure; friable; few thin dark brown (10YR 3/3) clay films on faces of peds; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bt2—14 to 19 inches; strong brown (7.5YR 5/6) sandy loam; moderate medium subangular blocky structure; friable; few thin dark brown (10YR 3/3) clay films on faces of peds and in pores; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

2BC—19 to 23 inches; dark brown (7.5YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

2C1—23 to 29 inches; dark yellowish brown (10YR 4/4) coarse sand; single grained; loose; about 10 percent coarse fragments; neutral; gradual wavy boundary.

2C2—29 to 60 inches; brown (10YR 5/3) gravelly coarse sand; single grained; loose; about 25 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 34 inches.

The A horizon has value of 2 or 3 and chroma of 1 through 3. The texture is dominantly sandy loam or loam.

The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 2 through 6. The texture is typically sandy loam, coarse sandy loam, or loam. Some pedons have a 2B horizon.

The 2C horizon has hue of 10YR or 7.5Y, value of 3 through 6, and chroma of 3 or 4. It is coarse sand or sand and the gravelly analogs. In places it is stratified. The 2C horizon is mildly alkaline or moderately alkaline.

Duelm Series

The Duelm series consists of somewhat poorly drained and moderately well drained, rapidly permeable soils on outwash plains. The soils formed in sandy outwash. Slopes range from 0 to 2 percent.

Duelm soils are similar to Osakis soils and commonly are adjacent on the landscape to Hubbard and Isan soils. Unlike Duelm soils, Osakis soils have free carbonates in the C horizon. Hubbard soils are upslope, and Isan soils are downslope from Duelm soils.

Typical pedon of Duelm loamy sand, 220 feet north and 1,610 feet east of the southwest corner of sec. 16, T. 124 N., R. 28 W.

A1—0 to 12 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak medium granular structure; very friable; about 1 percent coarse fragments; slightly acid; abrupt smooth boundary.

A2—12 to 19 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; very friable; about 1 percent coarse fragments; slightly acid; clear wavy boundary.

Bw1—19 to 25 inches; dark grayish brown (10YR 4/2) loamy sand; weak medium subangular blocky structure; very friable; about 2 percent coarse fragments; medium acid; clear wavy boundary.

Bw2—25 to 30 inches; dark grayish brown (10YR 4/2) loamy sand; weak fine subangular blocky structure;

very friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

BC—30 to 38 inches; grayish brown (10YR 5/2) coarse sand; common fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 5 percent coarse fragments; neutral; gradual wavy boundary.

C—38 to 60 inches; pale brown (10YR 6/3) coarse sand; common fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 5 percent coarse fragments; medium acid.

The thickness of the solum ranges from 32 to 60 inches. The depth to free carbonates ranges from 50 to 100 inches. The mollic epipedon ranges from 10 to 20 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loamy coarse sand, loamy sand, sand, or coarse sand. Reaction ranges from neutral to medium acid. In some pedons there is an AB horizon.

The B horizon has value of 4 or 5 and chroma of 2 or 3 in the upper part. In the lower part it has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 or 3. The B horizon is coarse sand, sand, loamy sand, or loamy coarse sand. Reaction ranges from neutral to strongly acid.

The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 or 3. It is 0 to 15 percent gravel-sized coarse fragments. The C horizon ranges from medium acid to neutral.

Eckvoll Series

The Eckvoll series consists of deep, moderately well drained soils. Permeability is moderately rapid in the upper part and moderate in the lower part. The soils are on sand-mantled ground and end moraines. They formed in the sandy material and in the underlying loamy glacial till. Slopes range from 1 to 3 percent.

Eckvoll soils are adjacent on the landscape to Cordova, Corunna, DeMontreville, Gonvick, Nebish, and Waukon soils. DeMontreville soils are on steeper slopes. Gonvick soils do not have a sandy mantle and are upslope. Nebish and Waukon soils are in higher positions on the landscape than Eckvoll soils. Cordova and Corunna soils are downslope.

Typical pedon of Eckvoll loamy sand, 100 feet east and 300 feet south of the northwest corner of sec. 12, T. 126 N., R. 34 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; few fine roots; slightly acid; abrupt smooth boundary.

E—9 to 22 inches; dark brown (10YR 4/3) fine sand; weak fine subangular blocky structure parting to single grained; very friable; few fine roots; slightly acid; abrupt wavy boundary.

2Bt1—22 to 40 inches; dark yellowish brown (10YR 4/4) sandy clay loam; common medium distinct grayish brown (10YR 5/2) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; friable; common thin dark grayish brown (10YR 4/2) clay films on faces of peds; about 2 percent coarse fragments; neutral; clear wavy boundary.

2Bt2—40 to 48 inches; yellowish brown (10YR 5/4) loam; few fine distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; few thin very dark grayish brown (10YR 3/2) clay films on faces of peds; about 4 percent coarse fragments; neutral; clear wavy boundary.

2C—48 to 60 inches; light olive brown (2.5Y 5/4) loam; common fine distinct grayish brown (10YR 5/2) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 50 inches. The thickness of the sandy sediment ranges from 20 to 46 inches.

The A1 or Ap horizon has value of 2 or 3 and chroma of 1 through 3. It is loamy fine sand, loamy sand, or fine sandy loam. The E horizon has value of 4 through 6 and chroma of 2 through 4. It is fine sand, sand, or loamy sand.

The 2Bt horizon has hue of 2.5Y or 10YR, value of 3 through 6, and chroma of 2 through 4.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. The C horizon is loam, clay loam, or silt loam.

Estherville Series

The Estherville series consists of deep, somewhat excessively drained soils. Permeability is moderately rapid in the upper part and rapid in the lower part. The soils are on outwash plains and stream terraces. They formed in loamy material and in the underlying calcareous, sandy outwash (fig. 10). The slopes range from 0 to 25 percent.

Estherville soils are similar to Dickman and Osakis soils and commonly are adjacent on the landscape to Hawick, Osakis, and Regal soils. Unlike Estherville soils, Dickman soils do not have free carbonates to a depth of 60 inches or more. Osakis soils have mottles in the lower part of the B horizon and in the C horizon. Hawick soils and Estherville soils are in similar positions on the landscape. Regal soils are downslope.

Typical pedon of Estherville sandy loam, 2 to 6 percent slopes, 2,560 feet west and 20 feet south of the northeast corner of sec. 23, T. 122 N., R. 29 W.

Ap—0 to 5 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium granular

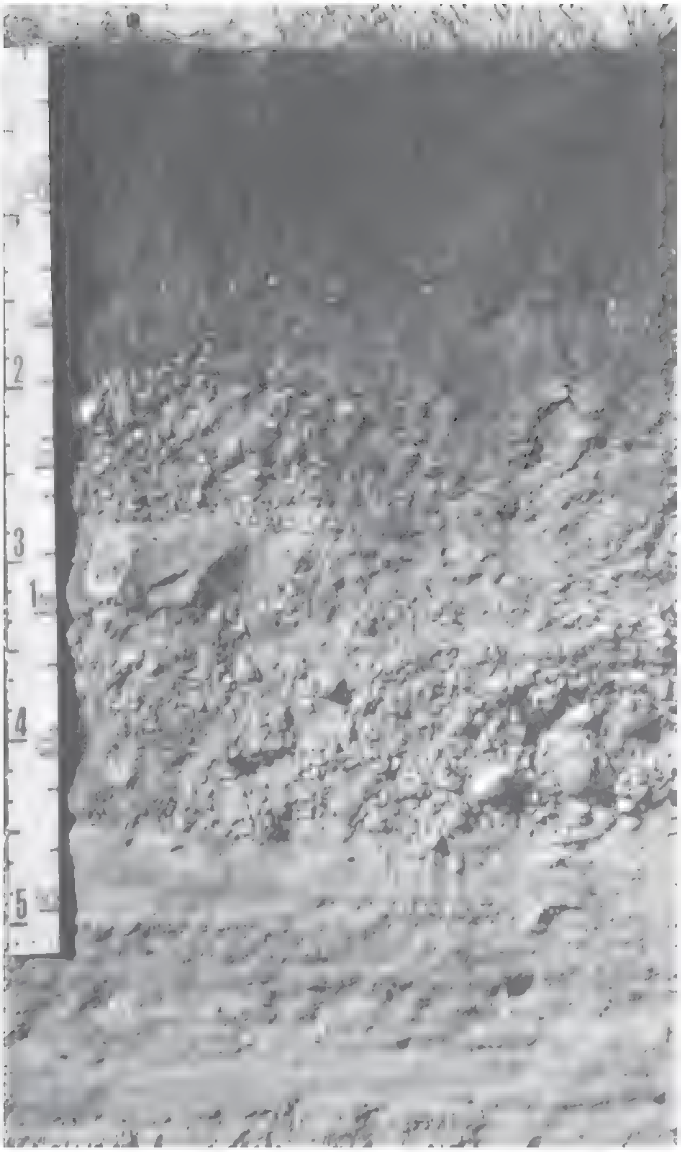


Figure 10.—Profile of Estherville sandy loam, 0 to 2 percent slopes, showing the dark surface layer and the contrasting, droughty underlying material.

structure; friable; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

A—5 to 10 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bw—10 to 15 inches; dark brown (10YR 4/3) sandy loam; weak fine and medium subangular blocky structure; friable; about 5 percent gravel; slightly acid; clear wavy boundary.

2BC—15 to 18 inches; dark yellowish brown (10YR 4/4) loamy coarse sand; weak fine subangular blocky structure; very friable; loose; about 10 percent gravel; neutral; clear wavy boundary.

2C1—18 to 25 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grained; loose; about 15 percent gravel; slight effervescence; mildly alkaline; clear smooth boundary.

2C2—25 to 60 inches; brown (10YR 5/3) and pale brown (10YR 6/3) gravelly coarse sand; single grained; loose; about 15 percent gravel; strong effervescence; mildly alkaline.

The solum is 15 to 24 inches thick. The depth to free carbonates and the depth to loamy sand or coarser material also range from 15 to 24 inches. The mollic epipedon is 9 to 16 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or loam. It is medium acid to neutral.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 3 or 4. It is sandy loam or loam in the upper part and grades to coarse sandy loam or loamy coarse sand in the lower part. Reaction is neutral or slightly acid.

The 2C horizon has value of 4 through 6 and chroma of 2 through 6. It is sand, coarse sand, or gravelly coarse sand. It is mildly alkaline or moderately alkaline.

Fairhaven Series

The Fairhaven series consists of deep, well drained soils. Permeability is moderate in the upper part and rapid in the lower part. The soils are on outwash plains and valley trains. They formed in a loamy mantle and the underlying sandy glacial outwash. The slopes range from 0 to 6 percent.

Fairhaven soils are similar to Dakota soils and commonly are adjacent to Biscay, Cylinder, and Estherville soils. Fairhaven and Dakota soils formed in similar material, but Dakota soils have an argillic horizon. Fairhaven soils and Estherville soils are in similar positions on the landscape. Biscay and Cylinder soils are downslope.

Typical pedon of Fairhaven loam, 0 to 2 percent slopes, 360 feet east and 130 feet south of the northwest corner of sec. 7, T. 122 N., R. 28 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; massive; friable; about 1 percent coarse fragments; slightly acid; clear wavy boundary.

A—8 to 15 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; friable; about 1 percent coarse fragments; slightly acid; clear wavy boundary.

AB—15 to 18 inches; dark brown (10YR 3/3) with streaks and pockets of very dark brown (10YR 3/2) loam, brown (10YR 5/3) dry; weak fine subangular

blocky structure; friable; about 1 percent coarse fragments; medium acid; clear wavy boundary.

Bw1—18 to 27 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; medium acid; clear wavy boundary.

Bw2—27 to 30 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; abrupt wavy boundary.

2BC—30 to 35 inches; dark yellowish brown (10YR 4/4) loamy coarse sand; single grained; loose; about 12 percent coarse fragments; neutral; clear wavy boundary.

2C—35 to 60 inches; light yellowish brown (10YR 6/4) coarse sand; single grained; loose; about 10 percent coarse fragments; very slightly effervescent; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 50 inches. The thickness of the loamy mantle, or the depth to contrasting material, is 22 to 40 inches. The mollic epipedon is 10 to 20 inches thick. In the contrasting underlying material, coarse fragments of gravel size make up 5 to 30 percent of the volume.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silt loam or loam. Reaction is slightly acid or neutral.

The B horizon has value of 3 through 5 and chroma of 3 or 4. It is loam or silt loam. Reaction ranges from medium acid to neutral.

The 2BC horizon is sandy loam, coarse sandy loam, loamy sand, or loamy coarse sand. Reaction ranges from medium acid to mildly alkaline.

The 2C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 through 5. It is gravelly coarse sand, coarse sand, or stratified sand and gravel. Reaction is mildly or moderately alkaline, but in some pedons there are no free carbonates in the upper part of the 2C horizon.

Fedji Series

The Fedji series consists of deep, somewhat excessively drained soils. Permeability is rapid in the upper part and moderate in the lower part. The soils are on sand-mantled ground moraines. They formed in sandy material over loamy glacial till. Slopes range from 2 to 6 percent.

Fedji soils are commonly adjacent on the landscape to Hubbard, Koronis, and Ves soils. Hubbard, Koronis, and Ves soils are in positions on the landscape similar to those of Fedji soils.

Typical pedon of Fedji loamy sand, 2 to 6 percent slopes, 100 feet west and 2,240 feet south of the center of sec. 4, T. 125 N., R. 33 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; few roots; medium acid; abrupt smooth boundary.

AB—9 to 12 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; few roots; medium acid; clear wavy boundary.

Bw1—12 to 19 inches; dark brown (10YR 3/3) fine sand; weak fine granular structure parting to single grained; very friable; medium acid; clear wavy boundary.

Bw2—19 to 27 inches; dark yellowish brown (10YR 4/4) fine sand; single grained; loose; medium acid; abrupt smooth boundary.

2Bw—27 to 40 inches; dark yellowish brown (10YR 4/4) loam; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

2C—40 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; few threads and masses of lime; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. The depth to loamy glacial till ranges from 20 to 40 inches. The mollic epipedon is 10 to 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loamy fine sand, loamy sand, or less commonly sand or sandy loam. Reaction is medium acid or slightly acid.

The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 or 4. It is loamy fine sand, loamy sand, fine sand, or sand. Reaction is medium acid or slightly acid. The 2B horizon has similar colors, but it is loam or clay loam. It is neutral or slightly acid.

The 2C horizon has value of 5 or 6 and chroma of 3 or 4. It is loam or clay loam. It is mildly alkaline or moderately alkaline. Mottling may be present in the 2C horizon.

Flak Series

The Flak series consists of deep, well drained, moderately slowly permeable soils on drumlins and ground moraines. The soils formed in noncalcareous, loamy glacial till. Slopes range from 4 to 40 percent.

Flak soils are similar to Cushing and Holdingford soils and are adjacent on the landscape to Brainerd, Nokay, and Prebish soils. Cushing soils have an argillic horizon. Holdingford soils formed in brown, noncalcareous till over gray, calcareous glacial till. They have an argillic horizon. Brainerd soils are in less sloping areas than Flak soils. Nokay soils are on low-lying flats. Prebish soils are on flats and in drainageways and wet depressions.

Typical pedon of Flak sandy loam, 8 to 15 percent slopes, 1,010 feet east and 1,520 feet north of the southwest corner of sec. 30, T. 124 N., R. 28 W.

A—0 to 3 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium and coarse crumb structure; very friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.

E—3 to 15 inches; brown (10YR 5/3) sandy loam, very pale brown (10YR 7/3) dry; weak thin and medium platy structure; very friable; about 5 percent coarse fragments; medium acid; clear wavy boundary.

BE—15 to 19 inches; dark brown (7.5YR 4/4) sandy loam; weak to moderate medium subangular blocky structure; very friable; about 20 percent coarse fragments; medium acid; clear wavy boundary.

Bx1—19 to 30 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure parting to moderate thin platy; firm; about 10 percent coarse fragments; thin dark reddish brown (5YR 3/4) clay films on most peds; medium acid; gradual wavy boundary.

Bx2—30 to 42 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure parting to weak medium platy; firm; about 10 percent coarse fragments; thin dark reddish brown (5YR 3/4) clay films on some peds; medium acid; gradual wavy boundary.

Cx—42 to 60 inches; dark brown (7.5YR 4/4) sandy loam; moderate thin and medium platy structure; firm, very firm in place; about 10 percent coarse fragments; slightly acid.

The solum ranges from 30 to 50 inches in thickness. The depth to the dense layers ranges from 16 to 28 inches. Coarse fragments of gravel size make up 10 to 20 percent of the solum and C horizon. In some places the A horizon contains as little as 2 percent of coarse fragments of gravel size.

The A horizon has value of 2 through 5 and chroma of 1 through 4. It is sandy loam or fine sandy loam. It is slightly acid to strongly acid.

The B horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or fine sandy loam. Reaction is strongly acid to slightly acid. The Bx horizon has value of 4 or 5 and chroma of 3 through 5. It is strongly acid to slightly acid. In some pedons there are mottles of high chroma in the lower part of the B horizon, and in some pedons reddish brown colors are interspersed in the matrix.

The Cx horizon has value of 4 or 5 and chroma of 3 through 5. It is medium acid or slightly acid.

Flom Series

The Flom series consists of deep, poorly drained, moderately slowly permeable soils on ground moraines. The soils formed in loamy glacial till. Slopes range from 0 to 2 percent.

Flom soils are similar to Cordova and Roliss soils and commonly are adjacent on the landscape to Glencoe and Normania soils. Cordova soils have an argillic horizon. Roliss soils are calcareous at a depth between 10 and 20 inches. Glencoe soils are in depressions. Normania soils are in higher positions on the landscape than Flom soils.

Typical pedon of Flom loam, 1,765 feet south and 60 feet west of the northeast corner of sec. 28, T. 126 N., R. 35 W.

Ap—0 to 9 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; common roots; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

A—9 to 17 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; few roots; about 1 percent coarse fragments; neutral; gradual smooth boundary.

Bg—17 to 24 inches; olive gray (5Y 5/2) clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; few roots; about 2 percent coarse fragments; neutral; clear wavy boundary.

Cgk—24 to 43 inches; light olive gray (5Y 6/2) loam; common fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 3 percent coarse fragments; common fine irregular light gray (10YR 7/1) threads and soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg—43 to 60 inches; olive gray (5Y 5/2) loam; many medium distinct olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) mottles; massive; friable; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 36 inches. The mollic epipedon ranges from 14 to 20 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. It is loam, silty clay loam, or clay loam.

The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The texture is silty clay loam, clay loam, or loam.

The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 through 3. The C horizon is loam or clay loam. Reaction is mildly alkaline or moderately alkaline.

Glencoe Series

The Glencoe series consists of deep, very poorly drained, moderately permeable and moderately slowly permeable soils on ground moraines. The soils formed in local alluvial sediment overlying loamy and silty glacial till. Slopes range from 0 to 2 percent.

Glencoe soils are similar to Hamel soils and commonly are adjacent on the landscape to Flom, Roliss, and Vallers soils. Hamel soils have an argillic horizon and are poorly drained. Typically, all of these soils are upslope from Glencoe soils.

Typical pedon of Glencoe loam, 525 feet north and 530 feet west of the southeast corner of sec. 36, T. 126 N., R. 35 W.

Ap—0 to 9 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common roots; neutral; abrupt smooth boundary.

A1—9 to 16 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; weak thick platy structure parting to weak fine and medium angular blocky; friable; few roots; neutral; clear wavy boundary.

A2—16 to 41 inches; black (2.5Y 2/1) silty clay loam, very dark gray (2.5Y 4/1) dry; few fine yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; few roots; few yellowish red (5YR 4/6) and brownish yellow (10YR 6/8) coatings in old root channels; neutral; clear wavy boundary.

Bg—41 to 55 inches; olive gray (5Y 4/2) silty clay loam, few tongues of very dark gray (N 3/0); few fine distinct light olive brown (2.5Y 5/6) and yellowish brown (10YR 5/6) mottles; massive; friable; few strong brown (7.5YR 5/6) and yellowish red (5YR 4/6) coatings in old root channels; neutral; gradual wavy boundary.

Cg—55 to 60 inches; grayish brown (2.5Y 2/2) loam; common medium distinct olive brown (2.5Y 4/4) mottles; massive; friable; few dark red (2.5YR 3/6) coatings in old root channels; about 2 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. The mollic epipedon ranges from 24 to 46 inches in thickness.

The A horizon has hue of 10YR or 5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. It is loam, clay loam, or silty clay loam. Reaction is neutral or slightly acid.

The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, clay loam, or silty clay loam. Reaction is neutral or mildly alkaline.

The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 2 through 4.

Gonvick Series

The Gonvick series consists of deep, moderately well drained and somewhat poorly drained, moderately permeable soils on ground moraines. The soils formed in loamy glacial till. Slopes range from 1 to 4 percent.

The Gonvick soils are similar to Normania soils and are commonly adjacent on the landscape to Cordova, Glencoe, Koronis, and Waukon soils. Cordova and Glencoe soils are in lower positions than Gonvick soils, and Koronis and Waukon soils are in higher positions. Normania soils do not have an argillic horizon.

Typical pedon of Gonvick loam, 1 to 2 percent slopes, 960 feet west and 175 feet south of the northeast corner of sec. 32, T. 127 N., R. 35 W.

Ap—0 to 5 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A—5 to 12 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bt1—12 to 18 inches; dark brown (10YR 4/3) clay loam; common medium faint dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; friable; common very dark grayish brown (10YR 3/2) clay films on faces of peds; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bt2—18 to 25 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; few thin very dark gray (10YR 3/1) clay films on faces of peds; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bt3—25 to 30 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few thin dark brown (10YR 3/3) clay films on faces of peds; about 5 percent coarse fragments; neutral; abrupt wavy boundary.

Ck—30 to 41 inches; grayish brown (2.5Y 5/2) loam; common medium light olive brown (2.5Y 5/6) and few medium distinct dark brown and brown (7.5YR 4/4) mottles; massive; friable; about 5 percent coarse fragments; many irregularly shaped pale yellow (5Y 7/2) filaments and soft masses of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.

C—41 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium faint grayish brown (2.5Y 5/2) and few medium distinct dark brown (7.5YR 4/4) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 36 inches. The mollic epipedon is 7 to 16 inches thick.

The A1 or Ap horizon has value of 2 or 3. The texture is loam, sandy loam, or fine sandy loam. Reaction is slightly acid or neutral. Some pedons have an E horizon.

The B horizon has hue of 10YR or 2.5Y. It has value of 4 or 5 and chroma of 2 or 3 in the upper part. In the lower part, it has chroma of 2 through 4. The B horizon has mottles that have chroma of 2 or less, or it has chroma of 2 in the matrix and has mottles of higher chroma. The B horizon is loam or clay loam. Reaction ranges from slightly acid in the upper part to mildly alkaline in the lower part. Clay films range from thin to thick and from patchy to continuous.

The C horizon has value of 5 or 6 and chroma of 2 through 4. It is loam or sandy loam.

Growton Series

The Growton series consists of deep, moderately well drained, moderately permeable soils on ground moraines and drumlin fields. The soils formed in noncalcareous, loamy till overlying calcareous, loamy till. Slopes range from 1 to 4 percent.

Growton soils are similar to Brainerd soils and are adjacent on the landscape to Flak, Holdingford, Nokay, and Prebish soils. Brainerd soils developed entirely in noncalcareous, loamy glacial till. Flak and Holdingford soils are in more sloping areas than Growton soils. Nokay and Prebish soils are in lower positions on the landscape.

Typical pedon of Growton sandy loam, 1 to 4 percent slopes, 380 feet west and 1,400 feet south of the northeast corner of sec. 1, T. 126 N., R. 30 W.

Ap—0 to 7 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium granular structure; friable; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

E—7 to 11 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) and light gray (10YR 7/2) dry; weak medium platy structure; friable; about 5 percent coarse fragments; medium acid; clear wavy boundary.

BE—11 to 14 inches; grayish brown (10YR 5/2) sandy loam; many medium distinct dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; medium acid; clear wavy boundary.

Bt1—14 to 27 inches; dark brown (7.5YR 4/4) sandy loam; many medium distinct reddish gray (5YR 5/2) mottles; moderate medium subangular blocky structure; friable; common moderately thick dark brown (7.5YR 4/2 and 3/2) clay films on faces of peds and lining voids; about 10 percent coarse fragments; medium acid; gradual wavy boundary.

Bt2—27 to 37 inches; brown (7.5YR 5/4) sandy loam; common medium distinct reddish gray (5YR 5/2) and reddish brown (5YR 5/3) mottles; moderate coarse subangular blocky structure; friable; common moderately thick and thin dark brown (7.5YR 4/2 and 3/2) clay films on faces of peds and lining voids; about 10 percent coarse fragments; medium acid; gradual wavy boundary.

2C—37 to 60 inches; yellowish brown (10YR 5/4) sandy loam; common medium faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; massive; friable; about 10 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. Gravel-sized coarse fragments make up 5 to 20 percent of the solum and the C horizon.

The A horizon has hue of 10YR or 7.5YR, value of 2 through 5, and chroma of 1 through 3. In some places there are faint or distinct mottles in the lower part of the E horizon. The A horizon is sandy loam, fine sandy loam, loamy sand, or loamy fine sand. Reaction ranges from neutral to strongly acid.

The B horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 through 5, and chroma of 2 through 4. It is sandy loam, fine sandy loam, or loam. In the upper 10 inches of the Bt horizon, there are faint or distinct mottles that have chroma of 2 or less. Some pedons have a BC horizon. Reaction ranges from strongly acid to neutral.

The 2C horizon has hue of 10YR, 7.5YR, or 2.5Y, value of 4 or 5, and chroma of 3 through 6. It is sandy loam or loam. Reaction is mildly alkaline or moderately alkaline.

Hamel Series

The Hamel series consists of deep, poorly drained, moderately slowly permeable soils on ground moraines. The soils formed in loamy alluvial or colluvial sediment overlying calcareous, loamy glacial till. Slopes range from 0 to 3 percent.

Hamel soils are similar to Glencoe soils and are commonly adjacent on the landscape to Flom, Ves, and Waukon soils. Unlike Hamel soils, Glencoe soils do not have an argillic horizon. Ves and Waukon soils are in higher positions. Flom soils and Hamel soils are in similar positions.

Typical pedon of Hamel loam, 1,360 feet south and 390 feet west of the northwest corner of sec. 6, T. 125 N., R. 34 W.

A1—0 to 12 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; many roots; neutral; clear wavy boundary.

A2—12 to 16 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; few roots; neutral; clear wavy boundary.

AB—16 to 23 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate fine subangular blocky; friable; few thin black (10YR 2/1) clay films on faces of peds; few roots; neutral; clear wavy boundary.

Btg1—23 to 28 inches; very dark gray (10YR 3/1) clay loam; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; many thin black (10YR 2/1) clay films on faces of peds; few roots; about 1 percent coarse fragments; neutral; clear wavy boundary.

Btg2—28 to 36 inches; olive gray (5Y 4/2) clay loam; few fine faint light olive brown (2.5Y 5/4) mottles; weak coarse prismatic structure parting to weak fine and medium subangular blocky; firm; many thin dark olive gray (5Y 3/2) clay films on faces of peds; few very dark gray (N 3/0) fillings in old root channels; about 2 percent coarse fragments; neutral; clear wavy boundary.

Bg—36 to 41 inches; olive gray (5Y 5/2) loam; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

Cg—41 to 60 inches; olive gray (5Y 5/2) loam; many medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; few irregular threads and masses of lime; about 2 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. The mollic epipedon is 24 to 40 inches thick.

The A horizon has value of 2 or 3 and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. It is loam, silt loam, or clay loam. Reaction is neutral or slightly acid.

The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1 or 2 in the upper part. In the lower part, it has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The B horizon is clay loam, silty clay loam, or loam. Reaction ranges from neutral to slightly acid.

The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 through 4. It is loam or clay loam.

Hawick Series

The Hawick series consists of deep, excessively drained, very rapidly permeable soils on outwash plains and stream terraces. The soils formed in sandy outwash. Slopes range from 2 to 40 percent.

Hawick soils are similar to and are adjacent to Estherville soils. Estherville soils have a loamy mantle 10 to 20 inches thick. They and Hawick soils are in similar positions on the landscape.

Typical pedon of Hawick loamy sand, 6 to 12 percent slopes, 350 feet north and 2,290 feet west of the southwest corner of sec. 7, T. 126 N., R. 32 W.

Ap—0 to 10 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

Bw1—10 to 15 inches; dark yellowish brown (10YR 4/4) loamy coarse sand; very weak fine subangular blocky structure; very friable; about 10 percent coarse fragments; neutral; clear smooth boundary.

Bw2—15 to 19 inches; dark yellowish brown (10YR 4/4) coarse sand; single grained; loose; about 10 percent coarse fragments; neutral; clear smooth boundary.

C1—19 to 26 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grained; loose; about 10 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

C2—26 to 60 inches; pale brown (10YR 6/3) coarse sand; single grained; loose; about 12 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 8 to 26 inches. The mollic epipedon ranges from 7 to 16 inches in thickness. Coarse fragments of gravel size make up, on the average, 5 to 35 percent of the volume in the 10- to 40-inch control section.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It is loamy sand, loamy coarse sand, coarse sandy loam, or sandy loam. Where the texture is sandy loam, the A horizon is less than 10 inches thick. Reaction is slightly acid to mildly alkaline.

The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 or 4. It is loamy sand, loamy coarse sand, coarse sand, or the gravelly analogs. Reaction is slightly acid to mildly alkaline.

The C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 2 through 4. It is coarse sand, sand, or the gravelly analogs. Reaction is mildly alkaline or moderately alkaline.

Holdingford Series

The Holdingford series consists of deep, well drained, moderately permeable soils on ground moraines and drumlin fields. The soils formed in noncalcareous, loamy till overlying calcareous, loamy till. Slopes range from 4 to 15 percent.

Holdingford soils are similar to Cushing, Nebish, and Waukon soils and are adjacent to Flak, Growton, and Nokay soils. Cushing soils formed entirely in noncalcareous, loamy glacial till. Nebish and Waukon soils formed entirely in calcareous, loamy glacial till.

Cushing, Nebish, and Waukon soils have a higher clay content in the argillic horizon than Holdingford soils. Flak soils are in positions similar to those of Holdingford soils. Nokay and Growton soils are downslope.

Typical pedon of Holdingford sandy loam, 4 to 8 percent slopes, 580 feet west and 1,230 feet south of the northeast corner of sec. 1, T. 126 N., R. 30 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; about 5 percent coarse fragments; medium acid; abrupt smooth boundary.

E—8 to 12 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; weak medium platy structure; friable; about 5 percent coarse fragments; medium acid; clear smooth boundary.

Bt1—12 to 21 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few thin and moderately thick dark brown (7.5YR 3/2) clay films on faces of peds and lining voids; about 5 percent coarse fragments; medium acid; clear wavy boundary.

Bt2—21 to 29 inches; brown (7.5YR 5/4) sandy loam; moderate medium subangular blocky structure; friable; common thin and moderately thick dark brown (7.5YR 3/2) clay films on faces of peds and lining voids; about 10 percent coarse fragments; medium acid; gradual wavy boundary.

Bt3—29 to 37 inches; brown (7.5YR 5/4) sandy loam; moderate coarse subangular blocky structure; friable; common thin and moderately thick dark brown (7.5YR 3/2 and 4/2) clay films on faces of peds and lining voids; about 10 percent coarse fragments; medium acid; clear wavy boundary.

C—37 to 60 inches; yellowish brown (10YR 5/4) sandy loam; massive; friable; about 10 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 26 to 60 inches. Gravel-sized coarse fragments make up 5 to 20 percent of the solum and the C horizon.

The A horizon has hue of 10YR or 7.5YR, value of 2 through 5, and chroma of 1 through 4. It is sandy loam, fine sandy loam, loamy sand, or loamy fine sand. Reaction ranges from neutral to strongly acid.

The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 or 4. It commonly is fine sandy loam, sandy loam, or loam. Some pedons have a B3 horizon. Reaction ranges from strongly acid to neutral.

The C horizon has value of 4 through 6 and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam. Reaction is mildly alkaline or moderately alkaline.

Hubbard Series

The Hubbard series consists of deep, excessively drained, rapidly permeable soils on outwash plains. The soils formed in thick sandy outwash (fig. 11). Slopes range from 0 to 12 percent.

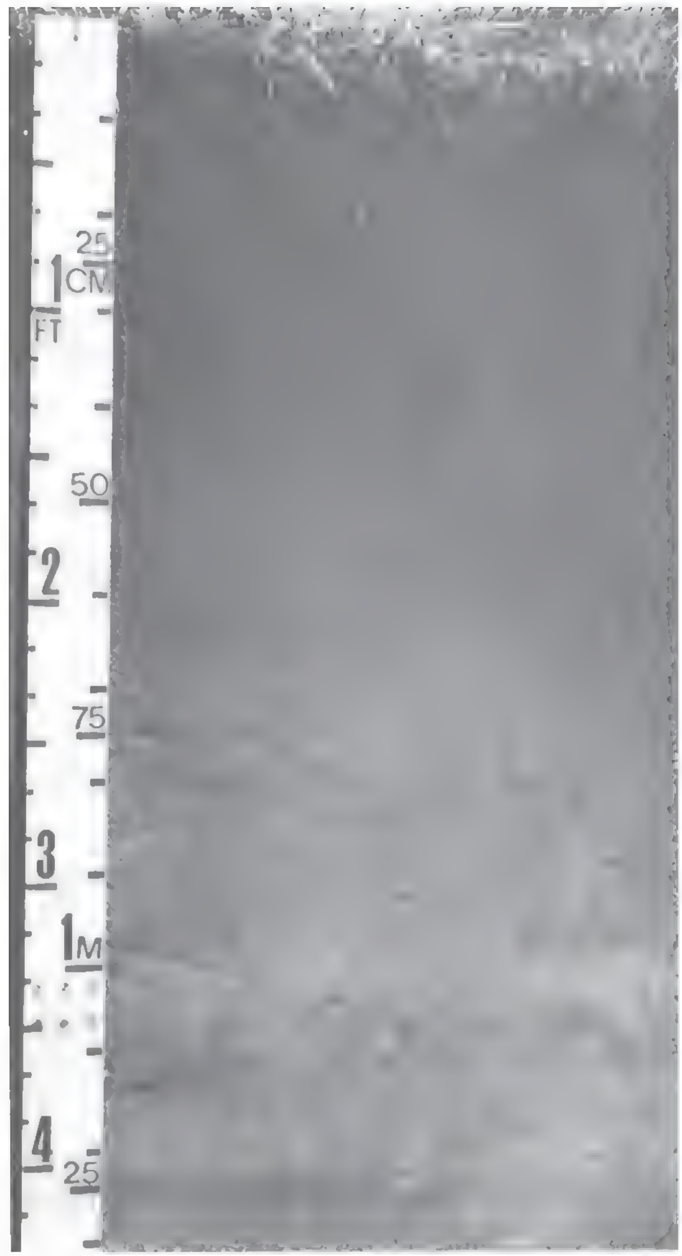


Figure 11.—Profile of Hubbard loamy sand, 0 to 2 percent slopes. The dark surface layer is typical of sandy soils that formed under the influence of savanna vegetation. The subsoil is about 25 inches thick. The underlying material is leached, light-colored sand.

Hubbard soils are similar to Hawick soils and commonly are adjacent on the landscape to Duelm and Isan soils. Hawick soils have carbonates within a depth of 30 inches. Duelm and Isan soils are in lower positions than Hubbard soils.

Typical pedon of Hubbard loamy sand, 0 to 2 percent slopes, 75 feet south and 2,275 feet west of the northeast corner of sec. 18, T. 123 N., R. 27 W.

A—0 to 7 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; very friable; strongly acid; clear smooth boundary.

AB—7 to 14 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; very friable; strongly acid; clear wavy boundary.

Bw—14 to 35 inches; dark brown and brown (7.5YR 4/4) sand; weak coarse subangular blocky structure; very friable; medium acid; clear wavy boundary.

BC—35 to 48 inches; yellowish brown (10YR 5/4) sand; weak very fine subangular blocky structure; about 1 percent coarse fragments; loose; medium acid; gradual wavy boundary.

C1—48 to 58 inches; yellowish brown (10YR 5/4) sand; common fine faint yellowish brown (10YR 5/8) mottles; single grained; loose; slightly acid; gradual wavy boundary.

C2—58 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; slightly acid.

The thickness of the solum ranges from 25 to 50 inches. The depth to free carbonates ranges from 50 to 80 inches. The mollic epipedon is 10 to 22 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is coarse sand, sand, loamy coarse sand, or loamy sand. In some pedons, it is coarse sandy loam or sandy loam in the uppermost 10 inches. Reaction is strongly acid to neutral.

The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 2 through 4. It is coarse sand, sand, loamy coarse sand, or loamy sand. Reaction is strongly acid through neutral.

The C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 2 through 5. It is coarse sand or sand. Reaction is slightly acid or neutral.

Isan Series

The Isan series consists of deep, poorly drained and very poorly drained, rapidly permeable soils on outwash plains and stream terraces. The soils formed in thick sandy outwash. Slopes range from 0 to 2 percent.

Isan soils are adjacent to Duelm, Hubbard, and Nymore soils. Duelm soils have redder hue and higher chroma in the upper part of the B horizon, and they are upslope from Isan soils. Hubbard and Nymore soils do not have mottles within a depth of 40 inches. They are in higher positions on the landscape.

Typical pedon of Isan loamy sand, 1,770 feet west and 1,480 feet south of the northeast corner of sec. 32, T. 126 N., R. 28 W.

A—0 to 13 inches; black (N 2/0) loamy sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; about 1 percent coarse fragments; medium acid; abrupt smooth boundary.

AB—13 to 20 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak medium subangular blocky structure; very friable; about 1 percent coarse fragments; medium acid; clear wavy boundary.

Bg—20 to 29 inches; dark grayish brown (2.5Y 4/2) coarse sand; common fine faint light olive brown (2.5Y 5/4) mottles; massive; loose; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

C—29 to 60 inches; grayish brown (2.5Y 5/2) sand; many coarse prominent yellowish brown (10YR 5/6) mottles; massive; loose; about 3 percent coarse fragments; neutral.

The thickness of the solum ranges from 20 to 30 inches, and the depth to free carbonates ranges from 60 to 100 inches. The mollic epipedon is 10 to 24 inches thick.

The A horizon has value of 2 or 3, or it is neutral in hue and has value of 2 and chroma of 0. It is typically loamy sand, but the range includes sandy loam and loamy coarse sand. Reaction is medium acid or slightly acid.

The B horizon has hue of neutral or 2.5Y, value of 4 or 5, and chroma of 2 or less if the hue is neutral, the chroma is less than 1.5. The B horizon is sand or coarse sand, but in some pedons it is loamy sand or loamy coarse sand in the upper part. Reaction ranges from strongly acid to neutral.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is sand or coarse sand. Reaction is medium acid to neutral.

Jewett Series

The Jewett series consists of deep, well drained, moderately permeable soils on ground and end moraines. The soils formed in a silty mantle over noncalcareous, loamy glacial till. Slopes range from 2 to 8 percent.

Jewett soils in this survey area have a yellower hue in the 2B horizon and are less acid in the argillic horizon than is defined for the Jewett series. These differences do not affect the use or behavior of the soil.

Jewett soils are adjacent on the landscape to Cushing, DeMontreville, Nokay, and Prebish soils. Cushing soils are in positions on the landscape similar to those of

Jewett soils. DeMontreville soils are in sloping areas. Prebish and Nokay soils are in depressions and drainageways.

Typical pedon of Jewett silt loam, 2 to 8 percent slopes, 330 feet west and 2,320 feet south of the center of sec. 12, T. 124 N., R. 30 W.

A—0 to 4 inches; very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

E1—4 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak thin platy structure; very friable; neutral; clear smooth boundary.

E2—8 to 13 inches; brown (10YR 5/2) silt loam; weak thin and medium platy structure; very friable; neutral; clear wavy boundary.

Bt1—13 to 21 inches; dark yellowish brown (10YR 4/4) silt loam; moderate fine and medium angular blocky structure; very friable; few thin dark brown (7.5YR 3/2) clay films on faces of peds; very pale brown (10YR 7/3) clean sand and silt grains coat some faces of peds; slightly acid; clear wavy boundary.

2Bt2—21 to 30 inches; dark yellowish brown (10YR 4/4) loam; moderate fine and medium angular blocky structure; friable; common thin dark brown (7.5YR 3/4) clay films on faces of peds; very pale brown (10YR 8/3) clean sand and silt grains coat some faces of peds; about 5 percent coarse fragments; slightly acid; clear irregular boundary.

2Bt3—30 to 36 inches; dark yellowish brown (10YR 4/4) fine sandy loam; moderate fine and medium subangular blocky structure; friable; thin continuous dark brown (7.5YR 3/2) clay films; yellowish brown (10YR 5/6) clean sand and silt grains coat some faces of peds; about 5 percent coarse fragments; slightly acid; gradual wavy boundary.

2BC—36 to 44 inches; yellowish brown (10YR 5/4) loam; weak fine subangular blocky structure; very friable; common thin dark brown (10YR 3/2) clay films; about 5 percent coarse fragments; strongly acid; gradual wavy boundary.

2C—44 to 60 inches; yellowish brown (10YR 5/4) loam; weak than platy structure or massive; very friable; strongly acid.

The thackness of the solum ranges from 25 to 45 inches. The thickness of the silty material ranges from 15 to 30 inches.

The A horizon has value of 2 through 5 and chroma of 1 through 4. It is silt loam or very fine sandy loam. Reaction ranges from strongly acid to neutral.

The B horizon has value of 4 or 5 and chroma of 3 through 5. It is silt loam, silty clay loam, loam, very fine sandy loam, or fine sandy loam. Coarse fragments make up 0 to 20 percent of the lower part of the B horizon. Reaction is strongly acid or moderately acid.

The 2C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is silt loam, loam, fine sandy loam, or sandy loam. Reaction is moderately acid or strongly acid.

Kalmarville Series

The Kalmarville series consists of deep, poorly drained and very poorly drained soils. Permeability is moderately rapid in the upper part and rapid in the lower part. The soils are on flood plains. They formed in loamy alluvial material over sandy material. Slopes range from 0 to 1 percent.

The Kalmarville soils in this survey area have a surface layer that is thicker and darker than is typical, and they are more calcareous than is defined for the Kalmarville series. These differences, however, do not affect the use or behavior of the soils.

Kalmarville soils are similar to Mayer and Regal soils and are adjacent on the landscape to Markey soils. Mayer and Regal soils have a loamy mantle less than 40 inches thick and are not subject to frequent flooding. Markey soils and Kalmarville soils are in similar positions, but Markey soils are farther from stream channels.

Typical pedon of Kalmarville sandy loam, frequently flooded, 300 feet west and 900 feet south of the northeast corner of sec. 18, T. 124 N., R. 28 W.

A1—0 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slight effervescence; mildly alkaline; diffuse wavy boundary.

A2—10 to 42 inches; black (10YR 2/1) sandy loam and loam, very dark gray (10YR 3/1) dry, with common strata of very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; few fine distinct dark grayish brown (2.5Y 4/2) mottles; few snail shells in lower part; slight effervescence; mildly alkaline; clear wavy boundary.

2C—42 to 60 inches; dark grayish brown (2.5Y 4/2) coarse sand; common medium distinct (10YR 5/6) mottles; single grained; loose; about 10 percent gravel; slight effervescence; mildly alkaline.

The depth to the 2C horizon ranges from 40 to 60 inches or more.

The A horizon typically has value of 2 through 4. In some pedons, thin strata of the A horizon have value of 5 or 6. The A horizon is sandy loam, fine sandy loam, loam, or silt loam, but in some pedons it is coarser in texture.

The 2C horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 1 or 2. It is coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand.

Koronis Series

The Koronis series consists of deep, well drained, moderately permeable and moderately rapidly permeable soils on ground moraines. The soils formed in loamy glacial till. Slopes range from 2 to 25 percent.

Koronis soils are similar to Ves soils and commonly are adjacent to Cordova, Hamel, Marcellon, and Sunburg soils. Ves soils have a mollic epipedon. They do not have an argillic horizon. Cordova, Hamel, and Marcellon soils are in lower positions on the landscape than Koronis soils. Sunburg soils and Koronis soils are in similar positions.

Typical pedon of Koronis loam, 2 to 6 percent slopes, 1,100 feet north and 1,800 feet east of the southwest corner of sec. 28, T. 133 N., R. 31 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

Bt1—8 to 15 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak fine and medium subangular blocky structure; friable; common moderately thick dark brown (7.5YR 3/2) clay films on faces of peds and in pores; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

Bt2—15 to 27 inches; brown and dark brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; common thin dark brown (10YR 3/3) clay films on faces of peds; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

C—27 to 37 inches; light olive brown (2.5Y 5/4) loam; massive with horizontal lamination; friable; about 5 percent coarse fragments; few fine irregularly shaped light gray (10YR 7/2) filaments and soft masses of lime; strong effervescence; mildly alkaline; clear wavy boundary.

Ck—37 to 43 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 7 percent coarse fragments; common fine irregularly shaped white (10YR 8/2) filaments and soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C'—43 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 7 percent coarse fragments; few fine irregularly shaped white (10YR 8/2) filaments and soft masses of lime; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 38 inches.

The Ap horizon has chroma of 1 or 2. In some pedons there is an A horizon that has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A horizon is loam or sandy loam and ranges from medium acid to neutral. Some pedons have an E horizon.

The upper part of the B horizon has value of 3 through 5 and chroma of 3 or 4; the lower part has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. The B horizon is loam, sandy clay loam, or fine sandy loam. The B horizon ranges from neutral to medium acid.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam.

Langola Series

The Langola series consists of deep, well drained and moderately well drained soils. Permeability is rapid in the upper part and moderately slow in the lower part. The soils are on ground moraines on the border of outwash plains and valley trains. They formed in a sandy mantle over noncalcareous, loamy glacial till. Slopes range from 1 to 4 percent.

Langola soils are similar to Pomroy soils and commonly are adjacent on the landscape to Brainerd, Flak, and Hubbard soils. Pomroy soils do not have a mollic epipedon. Brainerd soils are downslope. Flak soils are on steeper slopes than Langola soils, and Hubbard soils are on slightly higher convex knolls.

Typical pedon of Langola loamy sand, 1 to 4 percent slopes, 1,380 feet south and 60 feet west of the northeast corner of sec. 2, T. 126 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; medium acid; abrupt smooth boundary.

AB—10 to 19 inches; dark brown (10YR 3/3) loamy sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

Bw1—19 to 30 inches; dark yellowish brown (10YR 4/4) fine sand; weak medium and coarse subangular blocky structure; very friable; slightly acid; clear wavy boundary.

Bw2—30 to 38 inches; yellowish brown (10YR 5/4) fine sand; weak medium and coarse subangular blocky structure; very friable; slightly acid; clear irregular boundary.

2BC—38 to 49 inches; dark brown (7.5YR 4/4) sandy loam; few fine faint brown (7.5YR 5/2) and strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure parting to weak medium and thin platy; friable; about 5 percent coarse fragments; slightly acid; gradual wavy boundary.

2C—49 to 60 inches; dark brown (7.5YR 4/4) sandy loam; weak medium platy structure; firm; about 5 percent coarse fragments; slightly acid.

The thickness of the solum ranges from 36 to 50 inches, and the depth to sandy loam glacial till ranges from 25 to 40 inches. The mollic epipedon ranges from

10 to 16 inches in thickness. The 2B and 2C horizons commonly are 5 to 15 percent, by volume, gravel-sized coarse fragments. In some pedons there is a lag line between the two sediments.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It commonly is loamy fine sand or loamy sand, but the range includes sand and fine sand. Reaction is medium acid to neutral.

The B horizon has value of 4 or 5 and chroma of 3 or 4. In some pedons, there are mottles that have high chroma. The B horizon is loamy fine sand or fine sand in the upper part and sandy loam or fine sandy loam in the lower part. Reaction is slightly acid or medium acid.

The 2C horizon has hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 3 or 4. It is sandy loam or fine sandy loam. Reaction is slightly acid or neutral.

Litchfield Series

The Litchfield series consists of deep, moderately well drained and somewhat poorly drained, moderately rapidly permeable soils on glacial outwash plains and on stream terraces. The soils formed in stratified sandy and loamy outwash. Slopes range from 1 to 3 percent.

The Litchfield soils in this survey have more medium and coarse sand than is defined for the Litchfield series. This difference, however, does not affect the use or behavior of the soils.

Litchfield soils are similar to Duelm soils and commonly are adjacent to Darfur, Dassel, and Ridgeport soils. Duelm soils do not have banding in the outwash material. Darfur and Dassel soils are in lower positions on the landscape than Litchfield soils. Ridgeport soils are in higher positions.

Typical pedon of Litchfield loamy sand, 2,640 feet west of the southeast corner of sec. 19, T. 125 N., R. 28 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; very friable; about 2 percent coarse fragments; strongly acid; clear smooth boundary.

A—7 to 14 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; very friable; about 2 percent coarse fragments; medium acid; clear wavy boundary.

AB—14 to 19 inches; very dark grayish brown (10YR 3/2) loamy sand, light brownish gray (10YR 6/2) dry; weak thin and medium platy structure parting to weak medium subangular blocky; about 2 percent coarse fragments; medium acid; clear wavy boundary.

Bw1—19 to 28 inches; dark brown (10YR 4/3) loamy sand; few fine faint dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/6) mottles; weak medium and coarse subangular blocky structure; very friable; about 2 percent coarse fragments; slightly acid; abrupt wavy boundary.

Bw2—28 to 35 inches; yellowish brown (10YR 5/4) fine sand; common fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak medium and coarse subangular blocky structure; very friable to loose; about 2 percent coarse fragments; slightly acid; abrupt wavy boundary.

Bw3—35 to 43 inches; grayish brown (10YR 5/3) fine sandy loam; many coarse faint yellowish brown (10YR 5/6) mottles; weak thin to medium platy structure; very friable; strongly acid; clear wavy boundary.

C—43 to 60 inches; light brownish gray (10YR 6/2) sand; many coarse distinct strong brown (7.5YR 5/6) mottles; massive; very friable to loose; medium acid.

The thickness of the solum ranges from 30 to 60 inches. In some pedons, coarse fragments of gravel size range up to 20 percent, by volume, in the B and C horizons.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loamy fine sand or loamy sand, but the range includes fine sandy loam and sandy loam. Reaction ranges from slightly acid to strongly acid.

The B horizon has value of 3 through 5 and chroma of 2 through 4. In the upper part, it is fine sand or loamy fine sand; in the lower part it is fine sandy loam, very fine sandy loam, sandy clay loam, loamy fine sand, or fine sand. Reaction ranges from slightly acid to strongly acid.

The C horizon has hue of 2.5Y, 5Y, or 10YR, value of 5 or 6, and chroma of 1 through 3. It commonly has faint to prominent mottles. The C horizon is sand, fine sand, loamy sand, or loamy fine sand. In some pedons it is stratified. Reaction is medium acid to neutral.

Lowlein Series

The Lowlein series consists of deep, moderately well drained, moderately permeable soils on water-worked ground moraines. The soils formed in stratified loamy and sandy material overlying calcareous, loamy glacial till. Slopes range from 1 to 3 percent.

Lowlein soils are similar to Normania soils and commonly are adjacent on the landscape to Coriff and Corunna soils. Normania soils do not have a stratified upper mantle. They are fine-loamy. Coriff and Corunna soils are in lower positions on the landscape than Lowlein soils.

Typical pedon of Lowlein sandy loam, 60 feet north and 725 feet west of the southeast corner of sec. 24, T. 125 N., R. 34 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine and medium subangular blocky structure parting to weak

fine granular; very friable; few uncoated sand grains; few roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

AB—9 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; few roots; about 2 percent coarse fragments; neutral; clear wavy boundary.

Bw—13 to 21 inches; dark brown (10YR 4/3) sandy loam; weak fine and medium subangular blocky structure parting to weak fine granular; very friable; few roots; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

2Bw1—21 to 24 inches; dark yellowish brown (10YR 4/4) sand; few fine faint yellowish brown (10YR 5/6) mottles; single grained; loose; slightly acid; clear smooth boundary.

2Bw2—24 to 30 inches; light olive brown (2.5Y 5/4) loamy sand; few fine faint grayish brown (2.5Y 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; single grained; very friable; about 3 percent coarse fragments; neutral; abrupt wavy boundary.

3C—30 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct olive gray (5Y 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few soft fine threads and masses of lime; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and that of the stratified mantle range from 24 to 40 inches. The depth to free carbonates ranges from 24 to 40 inches also. The mollic epipedon ranges from 10 to 18 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 4. In places, the B horizon has few to many mottles that have chroma of 2 through 6. It is sandy loam in the upper part and loamy sand or sand in the lower part. Reaction is neutral to slightly acid.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 2 through 4. It has common to many mottles that have chroma of 2 through 6. The 2C horizon is loam or clay loam. Reaction is mildly alkaline or moderately alkaline.

Mahtomedi Series

The Mahtomedi series consists of deep, excessively drained, rapidly permeable soils on outwash plains and ground moraines. The soils formed in noncalcareous sandy outwash. Slopes range from 2 to 40 percent.

Mahtomedi soils are similar to Nymore soils and are adjacent on the landscape to Chetek, Cushing, and DeMontreville soils. Nymore soils formed in sandy drift and do not have coarse fragments. Chetek, Cushing, and DeMontreville soils are in positions similar to those of Mahtomedi soils.

Typical pedon of Mahtomedi loamy coarse sand, 8 to 15 percent slopes, 45 feet south and 1,000 feet west of the northeast corner of sec. 6, T. 125 N., R. 28 W.

A1—0 to 2 inches; black (10YR 2/1) loamy coarse sand, very dark brown (10YR 2/2) dry; weak fine granular structure; very friable; about 5 percent coarse fragments; slightly acid; abrupt wavy boundary.

A2—2 to 5 inches; very dark grayish brown (10YR 3/2) coarse sand, dark brown (7.5YR 4/4) dry; weak fine subangular blocky structure; very friable; about 5 percent coarse fragments; medium acid; clear smooth boundary.

Bw—5 to 25 inches; dark brown (7.5YR 4/4) coarse sand; single grained; very friable; about 10 percent coarse fragments; slightly acid; gradual wavy boundary.

C—25 to 60 inches; brown (7.5YR 5/4) gravelly coarse sand; single grained; loose; about 20 percent coarse fragments; slightly acid.

The solum ranges from 20 to 40 inches in thickness. In some pedons, the C horizon has free carbonates. On the average, the control section has between 10 and 35 percent gravel-sized coarse fragments, but in some pedons there is less than 10 percent or more than 35 percent.

The A horizon has hue of 7.5Y or 10YR, value of 2 through 4, and chroma of 1 through 3. Typically, it is loamy coarse sand or coarse sand, but the range includes loamy sand and sand. Reaction is strongly acid through slightly acid.

The B horizon has value of 4 or 5 and chroma of 4 or 5. Typically it is coarse sand, but in some places it is sand or fine sand. Reaction is strongly acid to slightly acid. Some pedons have a BC horizon.

The C horizon has value of 5 or 6 and chroma of 3 or 4. It is gravelly coarse sand, coarse sand, or sand. Reaction is strongly acid to mildly alkaline.

Marcellon Series

The Marcellon series consists of deep, somewhat poorly drained, moderately permeable and moderately rapidly permeable soils on ground moraines. The soils formed in loamy glacial till. Slopes range from 1 to 3 percent.

Marcellon soils are similar to Koronis soils and commonly are adjacent on the landscape to Cordova, Flom, Glencoe, Hamel, Koronis, and Sunburg soils. Koronis soils do not have mottles that have chroma of 2 or less in the uppermost 10 inches of the argillic horizon. They are in higher positions on the landscape than Marcellon soils. Cordova, Glencoe, Hamel, and Flom soils are in lower positions. Sunburg soils are upslope.

Typical pedon of Marcellon loam, 320 feet south and 1,290 feet west of the northeast corner of sec. 11, T. 122 N., R. 30 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; friable; many fine and very fine roots; about 5 percent coarse fragments; slightly acid; diffuse smooth boundary.

A—6 to 12 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; friable; many fine and very fine roots; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

AB—12 to 15 inches; very dark gray (10YR 3/1) loam; weak fine subangular blocky structure; friable; many fine and very fine roots; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

Bt1—15 to 20 inches; dark brown (10YR 4/3) sandy clay loam; few fine faint dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/8) mottles; moderate fine angular blocky structure; common very fine and micro roots; common moderately thick very dark gray (10YR 3/1) clay films on faces of peds; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

Bt2—20 to 26 inches; dark brown (10YR 4/3) sandy clay loam; few fine faint dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/8) mottles; moderate fine and medium prismatic structure parting to moderate fine angular blocky; friable; common fine and micro roots; continuous thick very dark brown (10YR 2/2) clay films on faces of peds and in pores; about 5 percent coarse fragments; neutral; abrupt wavy boundary.

Bt3—26 to 32 inches; brown (10YR 5/3) sandy clay loam; common fine faint light brownish gray (10YR 6/2) and yellowish brown (10YR 5/8) mottles; weak medium and coarse subangular blocky structure; friable; many very fine and micro roots; few thick black (10YR 2/1) clay films in tubular pores and root channels; about 10 percent coarse fragments; neutral; gradual wavy boundary.

Ck—32 to 37 inches; light olive brown (2.5Y 5/4) sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium platy structure; friable; about 10 percent coarse fragments; violent effervescence; moderately alkaline; clear smooth boundary.

C—37 to 60 inches; light olive brown (2.5Y 5/4) sandy loam; common medium faint light olive brown (2.5Y 5/6) mottles; massive; friable; about 10 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 25 to 38 inches. The mollic epipedon ranges from 10 to 17 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or fine sandy loam. Reaction is neutral or slightly acid.

The B horizon has value of 4 through 5 and chroma of 2 through 4. It is sandy clay loam, loam, or fine sandy loam. Reaction is moderately acid to mildly alkaline.

The C horizon has value of 5 or 6 and chroma of 2 through 4. It is sandy loam, fine sandy loam, or loam. The C horizon is mildly alkaline or moderately alkaline. The Ck horizon is not present in some pedons.

Markey Series

The Markey series consists of deep, very poorly drained, moderately rapidly permeable soils in closed depressions. The soils formed in highly decomposed herbaceous organic material overlying calcareous outwash. Slopes range from 0 to 2 percent.

Markey soils are similar to Cathro and Seelyeville soils and commonly are adjacent to Biscay, Mayer, and Regal soils. Cathro soils have a loamy 2C horizon. Seelyeville soils have 51 inches or more of sapric material. Biscay, Mayer, and Regal soils are slightly upslope.

Typical pedon of Markey muck, 2,045 feet south and 130 feet east of the northwest corner of sec. 19, T. 12 N., R. 35 W.

Oa1—0 to 10 inches; black (10YR 2/1) broken face and rubbed sapric material; about 60 percent fibers, 10 percent rubbed; weak thick platy structure parting to weak fine granular; very friable; fibers are primarily herbaceous; slightly acid; clear wavy boundary.

Oa2—10 to 25 inches; black (10YR 2/1) broken face and rubbed sapric material; about 15 percent fibers, less than 5 percent rubbed; weak fine subangular blocky structure parting to weak fine granular; very friable; fibers are primarily herbaceous; slightly acid; abrupt smooth boundary.

2C1—25 to 31 inches; gray (10YR 5/1) sandy loam; few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; strong effervescence; moderately alkaline; clear broken boundary.

2C2—31 to 60 inches; dark grayish brown (2.5Y 5/2) gravelly coarse sand; single grained; loose; slight effervescence; mildly alkaline.

The thickness of the sapric material ranges from 16 to 50 inches. The surface tier is hemic or sapric material. The subsurface tier typically is sapric material and includes less than 10 inches of hemic material. Some pedons have a 2Ab horizon that is up to 16 inches thick.

The organic part of the control section has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. Reaction is medium acid to neutral.

The 2C horizon has hue of 10YR through 2.5Y, value of 5 or 6, and chroma of 1 or 2. It is sand, sandy loam,

loamy sand, coarse sand, or gravelly coarse sand. Reaction is mildly alkaline or moderately alkaline.

Martisco Series

The Martisco series consists of deep, very poorly drained, slowly permeable soils. The soils formed in limnic lake sediment. Slopes range from 0 to 2 percent.

The Martisco soils in this survey area have a surface layer that is light in color and is composed of coprogenous material. These characteristics are outside the range that is defined for the Martisco series. The differences, however, do not affect the use or behavior of the soils.

Martisco soils are similar to Blue Earth soils and commonly are adjacent to Seelyeville and Blue Earth Variant soils. Blue Earth soils formed in calcareous coprogenous earth overlying calcareous glacial till. Seelyeville and Blue Earth Variant soils are in positions on the landscape similar to those of Martisco soils.

Typical pedon of Martisco mucky silt loam, 1,480 feet north and 2,120 feet west of the southeast corner of sec. 9, T. 124 N., R. 30 W.

A—0 to 9 inches; dark gray (10YR 4/1) coprogenous earth, light brownish gray (10YR 6/2) dry; 86 percent ash; 20 percent snail shells; 35 percent plant detritus; weak fine subangular blocky structure; very friable; 50 percent calcium carbonate; strong effervescence; moderately alkaline; abrupt wavy boundary.

2C1—9 to 27 inches; light gray (10YR 6/1) broken face marl, grayish brown (2.5Y 5/2) rubbed, light gray (10YR 7/1 and 10YR 7/2) dry; common fine distinct strong brown (7.5YR 5/6) mottles and fillings in root channels; 94 percent ash; 44 percent snail shells and plant detritus; weak medium and coarse subangular blocky structure; very friable; 40 percent calcium carbonate; violent effervescence; moderately alkaline; clear wavy boundary.

2C2—27 to 66 inches; grayish brown (2.5Y 5/2) and olive gray (5Y 4/2) marl, olive gray (5Y 5/2) rubbed, gray (5Y 6/1) dry; 93 percent ash; 30 percent snail shells; weak coarse prismatic structure; very friable; 40 percent calcium carbonate; violent effervescence; mildly alkaline; abrupt wavy boundary.

2C3—66 to 70 inches; gray (5Y 5/1) marl that has a high content of sand; massive; very friable; 97 percent ash; 20 percent snail shells; 30 percent calcium carbonate; strong effervescence; mildly alkaline.

The thickness of the coprogenous earth and marl and the depth to glacial till or to glacial lacustrine sediment typically are 47 to 95 inches, but the range is from 36 to 120 inches. The limnic material contains from 0 to 30 percent coarse fragments.

The coprogenous earth has hue of 10YR, 2.5Y, or 5Y, value of 2 through 4, and chroma of 1 or 2. Mineral content ranges from 60 to 90 percent. The coprogenous earth is neutral to moderately alkaline.

The marl has hue of 10YR, 2.5Y, or 5Y, value of 4 through 7, and chroma of 1 through 3. In some pedons there are mottles of high value and high chroma. Mineral content is 85 to 98 percent by weight. Plant detritus makes up less than 10 percent of the volume. The marl is neutral to moderately alkaline.

The underlying material has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. There are mottles in some pedons. The underlying material is loam, silt loam, or sandy loam. It is neutral or mildly alkaline.

Mayer Series

The Mayer series consists of deep, poorly drained and very poorly drained soils. The soils have moderate permeability in the upper part and rapid permeability in the underlying material. They are on outwash plains and stream terraces. The soils formed in a loamy mantle overlying calcareous sandy outwash. Slopes range from 0 to 2 percent.

These soils are taxadjuncts to the Mayer series because they do not have strongly contrasting particle-size classes in the control section. This difference, however, does not affect the use or behavior of the soils.

Mayer soils are similar to Biscay and Regal soils and commonly are adjacent on the landscape to Biscay, Estherville, and Osakis soils. Biscay soils are not calcareous in the upper part and are in positions similar to those of Mayer soils. Regal soils have a loamy mantle that is less than 20 inches thick. Estherville and Osakis soils are in higher positions on the landscape than Mayer soils.

Typical pedon of Mayer loam, 2,180 feet west and 1,050 feet north of the southeast corner of sec. 26, T. 124 N., R. 35 W.

A1—0 to 7 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; common roots; strong effervescence; mildly alkaline; clear smooth boundary.

A2—7 to 17 inches; very dark gray (N 3/0) loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; few roots; strong effervescence; mildly alkaline; gradual wavy boundary.

ABg—17 to 24 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; few roots; strong effervescence; mildly alkaline; clear wavy boundary.

Bg1—24 to 31 inches; dark gray (5Y 4/1) loam; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

Bg2—31 to 40 inches; gray (5Y 5/1) loam; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

2Cg—40 to 60 inches; olive gray (5Y 5/1) sand; single grained; loose; about 4 percent coarse fragments; strong effervescence; mildly alkaline.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has chroma of 0. It is loam or silt loam.

The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 1 through 3. It is loam or sandy clay loam. A thin 2BC horizon of sandy loam or loamy sand is in some pedons.

The 2C horizon has hue of 10YR, 5Y, or 2.5Y, value of 3 through 5, and chroma of 1 through 3. The C horizon is gravelly sand or sand. It is mildly alkaline or moderately alkaline.

Muskego Series

The Muskego series consists of deep, very poorly drained soils. Permeability is moderately rapid in the upper part and slow in the lower part. The soils formed in highly decomposed herbaceous material overlying coprogenous earth. Slopes range from 0 to 2 percent.

Muskego soils are similar to Blue Earth and Seelyeville soils and commonly are adjacent on the landscape to Cathro, Flom, and Roliss soils. Blue Earth soils have less than 8 inches of sapric material on the surface. Cathro soils are in positions similar to those of Muskego soils. Flom and Roliss soils are in higher positions. Seelyeville soils do not have coprogenous material within a depth of 51 inches.

Typical pedon of Muskego muck, 2,400 feet north and 1,200 feet west of the southeast corner of sec. 15, T. 125 N., R. 34 W.

Oa1—0 to 13 inches; black (10YR 2/1) rubbed sapric material; about 50 percent fibers, about 5 percent rubbed; massive; friable; fibers are primarily herbaceous; medium acid; clear wavy boundary.

Oa2—13 to 31 inches; black (10YR 2/1) broken face and rubbed sapric material; about 10 percent fibers, less than 2 percent rubbed; weak fine and medium subangular blocky structure; friable; fibers are primarily herbaceous; slightly acid; clear smooth boundary.

2C1—31 to 36 inches; dark olive gray (5Y 3/2) sedimentary peat; massive; friable; about 1 percent snail shells; slight effervescence; mildly alkaline; clear smooth boundary.

2C2—36 to 52 inches; dark olive gray (5Y 3/2) sedimentary peat; massive; friable; about 3 percent snail shells; strong effervescence; moderately alkaline; clear wavy boundary.

2C3—52 to 60 inches; very dark gray (5Y 3/1) sedimentary peat; massive; friable; about 1 percent snail shells; strong effervescence; moderately alkaline.

The depth to coprogenous earth is 16 to 51 inches. Typically, the depth to free carbonates is also 16 to 51 inches.

The upper organic material has hue of 7.5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly sapric material, but it can include as much as 10 inches of hemic material. Reaction is medium acid to neutral.

The coprogenous earth has hue of 2.5Y or 5Y, value of 3 or 4, and chroma of 1 or 2.

Nebish Series

The Nebish series consists of deep, well drained, moderately permeable soils on ground and end moraines (fig. 12). The soils formed in loamy glacial till. Slopes range from 2 to 40 percent.

Nebish soils are adjacent on the landscape to Beltrami, Bluffton, Shooker, and Waukon soils. Beltrami soils are in concave positions, and Bluffton soils are in deep depressions and potholes. Shooker soils are in level to slightly concave areas that surround wet depressions. Waukon soils are in positions on the landscape similar to those of Nebish soils.

Typical pedon of Nebish sandy loam, 8 to 15 percent slopes, 800 feet west and 120 feet north of the southeast corner of sec. 2, T. 125 N., R. 31 W.

A—0 to 4 inches; black (10YR 2/1) sandy loam, mixed with dark grayish brown (10YR 4/2), dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 3 percent coarse fragments; slightly acid; abrupt wavy boundary.

E—4 to 9 inches; dark grayish brown (10YR 4/2) sandy loam, mixed with very dark gray (10YR 3/1) and light grayish brown (10YR 6/2), dark gray (10YR 4/1) dry; moderate thick platy structure parting to weak very fine subangular blocky; very friable; 5 percent coarse fragments; neutral; clear wavy boundary.

Bt1—9 to 14 inches; dark yellowish brown (10YR 4/4) sandy clay loam; moderate coarse subangular blocky structure parting to moderate very fine subangular blocky; friable; common moderately thick dark brown (10YR 3/3) clay films on faces of peds; 4 percent coarse fragments; slightly acid; clear wavy boundary.

Bt2—14 to 24 inches; dark yellowish brown (10YR 4/4) sandy clay loam; strong coarse subangular blocky structure parting to moderate fine subangular blocky; friable; many thick dark brown (10YR 3/3) clay films on faces of peds and lining tubular pores; 5 percent coarse fragments; slightly acid; clear wavy boundary.

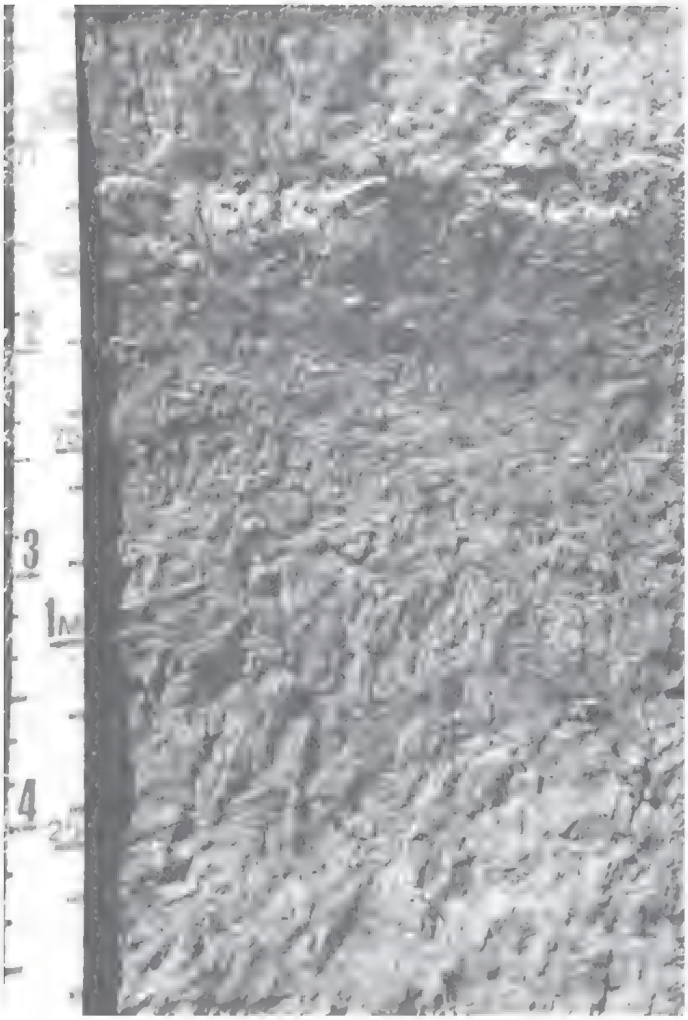


Figure 12.—Profile of Nebish sandy loam, 2 to 8 percent slopes. The leached, light-colored subsurface horizon contrasts strongly with the enriched, darker subsoil. The contrast is typical of soils that formed under forest vegetation.

Bt3—24 to 31 inches; yellowish brown (10YR 5/4) sandy clay loam; moderate thick platy structure parting to moderate fine subangular blocky; friable; few moderately thick dark brown (10YR 3/3) clay films on faces of peds; 5 percent coarse fragments; neutral; clear wavy boundary.

C1—31 to 38 inches; light olive brown (2.5Y 5/4) fine sandy loam; weak thick platy structure; friable; fine irregularly shaped light gray (2.5Y 7/2) lime filaments or threads; few reddish brown (5YR 4/4) iron concretions; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C2—38 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; weak thick platy structure; firm; fine irregularly shaped light gray (2.5Y 7/2) lime filaments or threads; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 36 inches. Coarse fragments of gravel size range from 2 to 8 percent in all horizons.

The A horizon has value of 2 through 5 and chroma of 1 or 2. It is loam, sandy loam, or fine sandy loam. Reaction is slightly acid or neutral.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is loam, sandy clay loam, or clay loam. Clay films are thin to thick and few to many. Reaction ranges from medium acid in the upper part to mildly alkaline in the lower part.

The C horizon has hue of 2.5Y, value of 5 or 6, and chroma of 3 or 4. It is loam, sandy loam, or fine sandy loam. It is mildly alkaline or moderately alkaline.

Nokay Series

The Nokay series consists of deep, somewhat poorly drained soils on drumlins and ground moraines. Permeability is moderately slow. The soils formed in noncalcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Nokay soils are adjacent on the landscape to Alstad, Brainerd, Pomroy, and Prebish soils. Alstad and Brainerd soils are more sloping and in higher positions than Nokay soils. Pomroy soils are also in higher positions. Prebish soils are in wet depressions and drainageways.

Typical pedon of Nokay fine sandy loam, 2,560 feet west and 95 feet south of the northeast corner of sec. 29, T. 124 N., R. 38 W.

A—0 to 4 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium granular structure; friable; about 5 percent coarse fragments; strongly acid; abrupt wavy boundary.

E1—4 to 7 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; many medium distinct dark brown (7.5YR 4/4) mottles; weak thin and medium platy structure; friable; about 5 percent coarse fragments; strongly acid; clear wavy boundary.

E2—7 to 12 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; many medium distinct dark brown (7.5YR 4/4) mottles; weak medium platy structure; friable; about 20 percent coarse fragments; strongly acid; gradual wavy boundary.

Btg1—12 to 16 inches; dark grayish brown (10YR 4/2) loam; brown (7.5YR 5/2) coatings on peds; many

medium distinct dark brown (7.5YR 4/4) mottles; weak thick platy structure that parts to weak medium subangular blocky; friable; about 10 percent coarse fragments; few thin very dark grayish brown (10YR 3/2) clay films in pores; strongly acid; clear wavy boundary.

Btg2—16 to 24 inches; dark brown (7.5YR 4/4) sandy loam; many medium distinct yellowish red (5YR 4/6) and light brownish gray (10YR 6/2) mottles; weak medium platy structure; firm; few thin brown (7.5YR 5/2) clay films on faces of peds; about 10 percent coarse fragments; strongly acid; gradual wavy boundary.

Bx—24 to 40 inches; dark brown (7.5YR 4/4) sandy loam; common medium prominent yellowish red (5YR 4/6), dark reddish brown (5YR 3/4), reddish brown (5YR 4/4), and brown (7.5YR 5/2) mottles; weak thick platy structure; firm; about 10 percent coarse fragments; medium acid; irregular wavy boundary.

Cx—40 to 60 inches; dark brown (7.5YR 4/4) sandy loam; common medium faint brown (7.5YR 5/2) mottles; weak thick platy structure; firm; about 10 percent coarse fragments; medium acid.

The thickness of the solum ranges from 38 to 50 inches, and the depth to the dense layer ranges from 22 to 36 inches. Coarse fragments of gravel size range from 10 to 20 percent, by volume, in the solum and the C horizon. Some pedons have a lag line in the horizon above the dense layer.

The A horizon has value of 2 through 5 and chroma of 1 or 2. It is sandy loam, fine sandy loam, or loam. Reaction is very strongly acid or strongly acid.

The B horizon has value of 4 or 5 and chroma of 2 through 4. Coatings on peds have chroma of 1 or 2. Mottles are faint through prominent. The B horizon is sandy loam, fine sandy loam, or loam. Clay films on faces of peds, in pores, and in root channels are thin to medium and patchy to continuous. Reaction ranges from strongly acid to slightly acid.

The Bx and Cx horizons have value of 4 or 5 and chroma of 3 through 5. There are faint to prominent mottles in the Bx horizon and the upper part of the Cx horizon. The texture is sandy loam or fine sandy loam. Reaction ranges from strongly acid to neutral.

Normania Series

The Normania series consists of deep, moderately well drained, moderately permeable soils on ground moraines. The soils formed in loamy glacial till. Slopes range from 1 to 5 percent.

Normania soils are similar to Ves soils and commonly are adjacent on the landscape to Flom and Roliss soils. Flom and Roliss soils are in lower positions than Normania soils. Ves soils do not have mottles that have chroma of 2 or less within a depth of 40 inches.

Typical pedon of Normania loam, 1 to 3 percent slopes, 580 feet north and 1,600 feet east of the center of sec. 23, T. 126 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; many roots; neutral; abrupt smooth boundary.

AB—9 to 14 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry! weak fine subangular blocky structure parting to weak fine and medium granular! friable; few roots; neutral; clear wavy boundary.

Bw1—14 to 19 inches; olive brown (2.5Y 4/4) loam; weak fine and medium subangular blocky structure; friable; few roots; about 5 percent coarse fragments; neutral; clear wavy boundary.

Bw2—19 to 26 inches; olive brown (2.5Y 4/4) loam; few fine distinct grayish brown (2.5Y 5/2) and few fine distinct dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

Ck—26 to 34 inches; light olive brown (2.5Y 5/3) loam; massive; friable; about 5 percent coarse fragments; many fine light gray (2.5Y 7/1) lime threads and masses; strong effervescence; moderately alkaline; clear wavy boundary.

C—34 to 60 inches; light olive brown (5Y 5/3) loam; common medium distinct grayish brown (2.5Y 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; few lime threads; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 36 inches. The mollic epipedon ranges from 10 to 16 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Reaction is neutral or slightly acid.

The B horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2 through 4. It is neutral or mildly alkaline.

The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 2 through 4.

Nymore Series

The Nymore series consists of deep, excessively drained, rapidly permeable soils on outwash plains and stream terraces. The soils formed in sandy outwash. Slopes range from 2 to 25 percent.

Nymore soils are similar to Duelm, Hubbard, and Isan soils and commonly are adjacent to them on the landscape. Duelm soils are somewhat poorly drained and moderately well drained. Unlike Nymore soils, they have a mollic epipedon and contain mottles that have

chroma of 2. They are downslope from Nymore soils. Hubbard soils have a mollic epipedon and are in positions similar to those of Nymore soils. Isan soils are very poorly drained and poorly drained and are in depressions. Isan soils have a mollic epipedon.

Typical pedon of Nymore loamy sand, 2 to 8 percent slopes, 400 feet north and 440 feet west of the southeast corner of sec. 26, T. 124 N., R. 28 W.

A—0 to 4 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium granular structure; very friable; medium acid; abrupt smooth boundary.

AB—4 to 9 inches; dark brown (10YR 3/3) loamy sand, yellowish brown (10YR 5/4) dry; weak medium and coarse subangular blocky structure; very friable; strongly acid; clear smooth boundary.

Bw1—9 to 25 inches; dark brown (7.5YR 4/4) sand; weak coarse subangular blocky structure; loose; strongly acid; gradual wavy boundary.

Bw2—25 to 31 inches; strong brown (7.5YR 5/6) sand; weak coarse subangular blocky structure; loose; strongly acid; clear wavy boundary.

BC—31 to 40 inches; yellowish brown (10YR 5/6) sand; single grained; loose; slightly acid; clear wavy boundary.

C1—40 to 53 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

C2—53 to 60 inches; pale brown (10YR 6/3) sand; common medium distinct yellowish brown (10YR 5/6) and brown (10YR 4/3) mottles; single grained; loose; slightly acid.

The thickness of the solum ranges from 24 to 42 inches. The depth to free carbonates ranges from 60 to 100 inches. Coarse fragments of gravel size range from 0 to 10 percent, by volume.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It is loamy sand, sand, loamy coarse sand, or coarse sand, but the range includes sandy loam and coarse sandy loam. Reaction is slightly acid to strongly acid.

The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 through 6. It is sand, coarse sand, or, less commonly, loamy sand or loamy coarse sand. Reaction is strongly acid to slightly acid.

The C horizon has hue of 10YR or 7.5YR, value of 5 through 7, and chroma of 2 through 4. It is sand or coarse sand. Reaction is slightly acid to strongly acid.

Osakis Series

The Osakis series consists of deep, moderately well drained soils. Permeability is moderate or moderately rapid in the upper part and rapid in the lower part. The soils are on outwash plains and stream terraces. They formed in 12 to 20 inches of loamy material and in the underlying sandy outwash. Slopes range from 0 to 2 percent.

Osakis soils are similar to Estherville soils and commonly are adjacent on the landscape to Estherville and Regal soils. Estherville soils do not have mottles in the lower part of the B horizon and the C horizon. They are upslope from Osakis soils. Regal soils are downslope.

Typical pedon of Osakis loam, 240 feet north and 2,550 feet east of the southwest corner of sec. 33, T. 127 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; very friable; common roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

AB—9 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; common roots; about 2 percent coarse fragments; neutral; clear wavy boundary.

Bw—13 to 19 inches; dark yellowish brown (10YR 3/4) sandy loam; weak fine subangular blocky structure parting to weak fine granular; friable; few roots; about 2 percent coarse fragments; neutral; clear wavy boundary.

2Bw—19 to 24 inches; dark yellowish brown (10YR 4/4) loamy coarse sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; few organic stains on sand grains; neutral; clear wavy boundary.

2C1—24 to 38 inches; grayish brown (10YR 5/2) coarse sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 10 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

2C2—38 to 60 inches; grayish brown (2.5Y 5/2) gravelly coarse sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 20 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 30 inches. The depth to loamy sand or coarser material is 12 to 22 inches. The mollic epipedon ranges from 12 to 18 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Reaction is neutral or slightly acid.

The B horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2 through 4. It is sandy loam or coarse sandy loam. Reaction is neutral or slightly acid.

The 2B horizon is loamy coarse sand, loamy sand, coarse sand, or sand.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is sand, coarse sand, gravelly sand, or gravelly coarse sand. Reaction is mildly alkaline or moderately alkaline.

Pomroy Series

The Pomroy series consists of deep, well drained and moderately well drained soils. The permeability is rapid in the upper part and moderately slow in the lower part. The soils are on ground moraines. They formed in a sandy mantle over noncalcareous, loamy till. Slopes range from 1 to 8 percent.

Pomroy soils are similar to Langola soils and commonly are adjacent on the landscape to Brainerd, Flak, and Watab soils. Unlike Pomroy soils, Langola soils have a mollic epipedon. Brainerd and Watab soils are downslope. Flak soils typically have steeper slopes than Pomroy soils.

Typical pedon of Pomroy fine sand, 1 to 8 percent slopes, 1,075 feet east and 125 feet south of the northwest corner of sec. 28, T. 125 N., R. 28 W.

Ap—0 to 9 inches; dark brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; weak fine crumb structure; very friable; medium acid; abrupt smooth boundary.

AB—9 to 25 inches; brown (10YR 5/3) fine sand; single grained; very friable; medium acid; clear wavy boundary.

2Bw—25 to 29 inches; dark brown (7.5Y 4/4) gravelly loamy fine sand; common fine distinct dark reddish brown (5YR 3/4) and yellowish red (5YR 5/6) mottles; massive; very friable; about 20 percent rounded and subrounded coarse fragments mainly 1/12 inch to 3 inches across; medium acid; clear smooth boundary.

3Bx—29 to 39 inches; dark brown (7.5YR 4/4) sandy loam; common fine distinct yellowish red (5YR 5/6) mottles; weak thick platy structure; firm; few thin dark brown (7.5YR 3/2) patchy clay films in pores; about 10 percent rounded and subrounded coarse fragments mainly 1/4 inch to 2 inches across; medium acid; gradual wavy boundary.

3Cx—39 to 60 inches; dark brown (7.5YR 4/4) sandy loam; massive; very firm; about 10 percent coarse fragments mainly 1/4 inch to 2 inches across; slightly acid.

The thickness of the solum ranges from 30 to 50 inches, and the depth to the fragipan ranges from 20 to 40 inches. Horizons in the upper sediment do not have coarse fragments, but coarse fragments of gravel size commonly make up 10 to 20 percent, by volume, of the 2B and 3C horizons.

The A horizon has value of 2 through 4 and chroma of 1 through 3. It is dominantly loamy fine sand or fine sand, but the range includes loamy sand and sand.

The 2B horizon in the upper sediment has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is loamy fine sand or sand.

The 3Bx and 3Cx horizons have hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 3 through 6. The texture is dominantly sandy loam or fine sandy loam. The 3B and 3C horizons are medium acid to neutral.

Prebish Series

The Prebish series consists of deep, very poorly drained and poorly drained soils on drumlin fields and on ground and end moraines. Permeability is moderately slow. The soils formed in modified, noncalcareous, loamy glacial till. Slopes range from 0 to 1 percent.

Prebish soils are similar to Corunna soils and are adjacent on the landscape to Alstad, Brainerd, Growton, and Nokay soils. Unlike Prebish soils, Corunna soils have a C horizon, at a depth of 26 to 40 inches, that is mildly alkaline and moderately alkaline. Alstad and Brainerd soils are more sloping than Prebish soils. Growton and Nokay soils are on higher lying flats and on the rim of depressions.

Typical pedon of Prebish sandy loam, depressional, 190 feet south and 25 feet west of the center of sec. 6, T. 125 N., R. 28 W.

A1—0 to 13 inches; black ±N 2/0! sandy loam, very dark gray ±10YR 3/1) dry! weak medium granular structure; friable; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

A2—13 to 18 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry! weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

BA—18 to 32 inches; dark grayish brown (2.5Y 4/2) sandy loam; common fine prominent dark brown (7.5YR 4/4) mottles; weak thin and medium platy structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

Bg—32 to 42 inches; grayish brown (2.5Y 5/2) sandy loam; many medium faint dark olive brown (2.5Y 4/4) mottles; weak thin platy structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

BC—42 to 47 inches; grayish brown (2.5Y 5/2) loam; many coarse distinct brown (7.5YR 5/2) mottles; weak thin platy structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

2C—47 to 60 inches; dark brown (7.5YR 4/4) sandy loam; many coarse distinct grayish brown (10YR 5/2) mottles; weak medium and thick platy structure; firm; about 5 percent coarse fragments; neutral.

The thickness of the solum ranges from 40 to 60 inches. In some pedons, free carbonates are in the lower part of the solum and the C horizon. Coarse fragments

of gravel size range from 5 to 15 percent, by volume, in the lower part of the solum and in the C horizon and from 2 to 5 percent, by volume, in the upper part of the solum. In some pedons there is a histic horizon that is as much as 8 inches thick. The mollic epipedon ranges from 13 to 18 inches in thickness. Reaction in the solum ranges from medium acid through moderately alkaline.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3 and chroma of 1 or 0; if hue is neutral, the chroma is 0. The histic layer, where present, has hue of 7.5YR or 5YR. In some pedons, there are distinct or prominent mottles in the lower part of the A horizon. The A horizon is loam, sandy loam, or fine sandy loam.

The B horizon has hue of 10YR, value of 4 or 5, and chroma of 1, or it has hue of 5YR, 2.5Y, or 5Y and chroma of 3 or less. Mottles are faint through prominent throughout the horizon. The B horizon is fine sandy loam, sandy loam, or loam.

The C and 2C horizons have hue of 7.5YR or 5YR, value of 3 through 5, and chroma of 3 or 4. Reaction typically is neutral, but it ranges from slightly acid through moderately alkaline.

Regal Series

The Regal series consists of deep, poorly drained soils. Permeability is moderate in the loamy mantle and rapid in the underlying material. The soils are on outwash plains or stream terraces. They formed in loamy material overlying sandy outwash. Slopes range from 0 to 2 percent.

Regal soils are similar to Biscay and Mayer soils and commonly are adjacent to Osakis and Estherville soils. Biscay and Mayer soils are deeper to sand and gravel than Regal soils. Osakis and Estherville soils are in higher positions on the landscape.

Typical pedon of Regal loam, 1,080 feet south and 20 feet east of the northwest corner of sec. 11, T. 122 N., R. 32 W.

Ap—0 to 6 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak medium granular structure; friable; few uncoated sand grains; abundant roots; slight effervescence; mildly alkaline; clear smooth boundary.

A—6 to 12 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; abundant roots; slight effervescence; mildly alkaline; clear wavy boundary.

AB—12 to 15 inches; very dark grayish brown (2.5Y 3/2) loam, gray (10YR 5/1) dry; weak coarse subangular blocky structure; friable; plentiful roots; about 3 percent coarse fragments; slight effervescence; clear smooth boundary.

Bg—15 to 18 inches; dark grayish brown (2.5Y 4/2) sandy loam; common medium faint dark gray (5Y 4/1) mottles; weak coarse subangular blocky structure; very friable; slight effervescence; mildly alkaline; abrupt wavy boundary.

2Cg1—18 to 24 inches; grayish brown (2.5Y 5/2) loamy coarse sand; common coarse faint dark grayish brown (2.5Y 4/2) mottles; single grained; loose; about 10 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

2Cg2—24 to 60 inches; light brownish gray (2.5Y 6/2) gravelly coarse sand; common coarse distinct olive brown (2.5Y 4/4) mottles; single grained; loose; about 20 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and of the mollic epipedon and the depth to loamy sand or coarser material range from 10 to 20 inches. The depth to free carbonates ranges from 0 to 20 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 and chroma of 0. It is loam, clay loam, or sandy clay loam.

The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam or sandy clay loam in the upper part and sandy loam or loamy sand in the lower part.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It is mildly alkaline or moderately alkaline.

Ridgeport Series

The Ridgeport series consists of deep, somewhat excessively drained soils on outwash plains and valley trains. Permeability is moderately rapid. The soils formed in stratified loamy and sandy outwash. Slopes range from 0 to 6 percent.

Ridgeport soils are similar to Dakota and Dickman soils and are adjacent on the landscape to Biscay, Dassel, Estherville, Fairhaven, and Litchfield soils. Dakota soils have a loamy mantle that is 20 to 40 inches thick over sand and gravel, and they have a fine-loamy argillic B horizon. Dickman soils have more sand in the B horizon than Ridgeport soils and do not have an argillic horizon. Biscay soils are in low lying, level areas and in depressions. Dassel, Estherville, and Fairhaven soils are in positions on the landscape similar to those of Ridgeport soils. Litchfield soils are downslope.

Typical pedon of Ridgeport sandy loam, 0 to 2 percent slopes, 923 feet east and 165 feet north of the southwest corner of sec. 35, T. 123 N., R. 29 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; massive parting to weak medium and fine granular structure; very friable; about 2 percent coarse fragments; medium acid; clear wavy boundary.

A—8 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 5/3) dry; few mixings of very dark brown (10YR 2/2) material; weak fine granular structure; very friable; about 2 percent coarse fragments; medium acid; gradual wavy boundary.

Bw2—13 to 22 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium and fine subangular blocky structure; very friable; about 2 percent coarse fragments; medium acid; clear wavy boundary.

Bwt—22 to 34 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; friable; about 4 percent coarse fragments; medium acid; clear wavy boundary.

2BC—34 to 43 inches; yellowish brown (10YR 5/4) sand; single grained; loose; about 8 percent coarse fragments; pebble band at the top, a dark brown band at the bottom; medium acid; abrupt wavy boundary.

2C—43 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; about 10 percent coarse fragments; mildly alkaline; slight effervescence.

The thickness of the solum and the depth to free carbonates range from 40 to 55 inches. Coarse fragments of gravel size range from 1 to 10 percent, by volume, in parts of the solum. The mollic epipedon ranges from 10 to 15 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, coarse sandy loam, or loamy sand. It is medium acid or slightly acid.

The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 in the upper part and 4 or 5 in the lower part, and chroma of 3 or 4. The B horizon is loamy coarse sand, sandy loam, coarse sandy loam, loam, or sandy clay loam, and includes bands of sand, coarse sand, and loamy coarse sand. In some pedons there is a band or lamella of darker color between the 2B and 2C horizons.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 3 or 4. The 2C horizon is coarse sand or sand. In some places it is stratified. Coarse fragments of gravel size make up as much as 10 percent.

Rifle Series

The Rifle series consists of deep, very poorly drained soils. Permeability is moderate and moderately rapid. The soils are in bogs or potholes on outwash plains and ground moraines. They formed in partly decomposed herbaceous organic deposits. Slopes are less than 2 percent.

Rifle soils are adjacent on the landscape to Cathro, Markey, and Seelyeville soils. Cathro and Markey soils have loamy or sandy underlying material at a depth of 51 inches or less. Seelyeville soils have dominantly sapric material in the subsurface and bottom tiers. All of these soils are in positions on the landscape similar to those of Rifle soils.

Typical pedon of Rifle mucky peat, 1,000 feet west and 1,800 feet north of the southeast corner of sec. 17, T. 125 N., R. 29 W.

Oa—0 to 8 inches; black (10YR 2/1) broken face and rubbed sapric material; about 40 percent fiber, about 10 percent rubbed; weak thin platy structure; very friable; primarily herbaceous fibers; neutral; clear smooth boundary.

Oe1—8 to 32 inches; very dark brown (10YR 2/2) broken face and rubbed hemic material; about 40 percent fiber, about 20 percent rubbed; moderate thin platy structure; nonsticky; herbaceous fibers; neutral; gradual wavy boundary.

Oe2—32 to 60 inches; very dark brown (10YR 2/2) broken face and rubbed hemic material; about 30 percent fiber, about 20 percent rubbed; weak thin platy structure; slightly sticky; herbaceous fibers; slightly acid.

The thickness of the organic soil material commonly is 6 to 10 feet or more. The organic material is mainly of herbaceous origin, but woody fragments make up as much as 15 percent, by volume, of some pedons. The reaction in all parts of the subsurface and bottom tiers ranges from medium acid to neutral.

The surface tier is variable and ranges from fibric to sapric material, depending on the stage of decomposition. The surface tier has hue of 10YR to 5YR, value of 2 through 6, and chroma of 1 through 4.

The subsurface and bottom tiers have hue of 10YR through 5YR, value of 2 through 4, and chroma of 2 through 4. In some pedons there are layers of sapric or fibric material less than 10 inches thick.

Roliss Series

The Roliss series consists of deep, poorly drained soils on ground moraines. Permeability is moderately slow. The soils formed in calcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Roliss soils are similar to Coriff soils and commonly are adjacent to Bluffton, Flom, Glencoe, and Normania soils. Coriff soils are coarse-loamy. Bluffton and Glencoe soils are in depressions. Normania soils are in higher positions on the landscape than Roliss soils. Flom soils and Roliss soils are in similar positions.

Typical pedon of Roliss loam, 390 feet west and 20 feet south of the center of sec. 6, T. 124 N., R. 34 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; common roots; slight

effervescence; mildly alkaline; abrupt smooth boundary.

AB—10 to 14 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; few roots; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Bg—14 to 22 inches; olive gray (5Y 5/2) loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Ckg—22 to 32 inches; light olive gray (5Y 6/2) loam; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

Cg—32 to 60 inches; olive gray (5Y 5/2) loam; common fine and medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 20 to 36 inches in thickness. The mollic epipedon ranges from 14 to 24 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1, or it is neutral in hue and has chroma of 0. It is loam or clay loam.

The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam or clay loam.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 through 4.

Seelyeville Series

The Seelyeville series consists of deep, very poorly drained soils. Permeability is moderately rapid to moderately slow. The soils are in postglacial lake basins. They formed in highly decomposed herbaceous material. Slopes range from 0 to 2 percent.

Seelyeville soils are similar to Muskego soils and commonly are adjacent to Cathro and Markey soils. Muskego soils have limnic sediment at a depth between 12 and 51 inches. Cathro and Markey soils are in positions on the landscape similar to those of Seelyeville soils.

Typical pedon of Seelyeville muck, 660 feet north and 2,245 feet west of the southeast corner of sec. 20, T. 124 N., R. 35 W.

Oa1—0 to 10 inches; very dark brown (10YR 2/2) and black (10YR 2/1) rubbed and pressed sapric material; about 10 percent fiber, less than 5 percent rubbed; weak fine granular structure; very friable; slightly acid; clear smooth boundary.

Oa2—10 to 23 inches; very dark brown (10YR 2/2) and black (10YR 2/1) rubbed and pressed sapric material; about 15 percent fiber, about 5 percent rubbed; weak fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.

Oa3—23 to 50 inches; very dark brown (10YR 2/2) and black (10YR 2/1) rubbed and pressed sapric material; about 20 percent fiber, about 5 percent rubbed; weak fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.

Oa4—50 to 60 inches; black (10YR 2/1) broken face sapric material, black (10YR 2/1) rubbed and pressed; about 10 percent fiber, less than 5 percent rubbed; weak fine subangular blocky structure; very friable; slightly acid.

The thickness of the organic layer ranges from 51 to 100 inches. The surface tier typically is sapric material; however, in places hemic and limnic materials make up part or all of the surface tier. The subsurface and bottom tiers typically are sapric, but in some pedons there is as much as 10 inches of hemic material. The sapric material has value of 2 or 3 and chroma of 1 or 2. The hemic material has value of 2 or 3 and chroma of 2 or 3. Reaction is moderately acid through neutral throughout.

Shooker Series

The Shooker series consists of deep, poorly drained, moderately permeable soils on ground and end moraines. The soils formed in loamy glacial till. Slopes range from 0 to 2 percent.

Shooker soils are adjacent on the landscape to Beltrami, Bluffton, and Nebish soils. Beltrami soils are on nearly level to slightly convex slopes. Bluffton soils are in depressions and potholes. Nebish soils are in higher positions on the landscape than Shooker soils.

Typical pedon of Shooker loam, 2,880 feet west and 1,800 feet south of the northeast corner of sec. 19, T. 126 N., R. 31 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, light gray (10YR 6/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; medium acid; abrupt smooth boundary.

E1—6 to 9 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 6/1) dry; weak medium platy structure parting to weak fine granular; friable; about 3 percent coarse fragments; medium acid; clear smooth boundary.

E2—9 to 15 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 6/1) dry; weak thin platy structure; friable; about 5 percent coarse fragments; medium acid; clear wavy boundary.

Bt1—15 to 19 inches; dark grayish brown (2.5Y 4/2) loam; few fine prominent dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; firm; light brownish gray (2.5Y 6/2) silt coats on faces of peds; few thin very dark gray

(10YR 3/1) clay films on faces of peds and lining tubular pores; about 3 percent coarse fragments; medium acid; abrupt smo ..ı boundary.

Bt2—19 to 30 inches; dark grayish brown (2.5Y 4/2) loam; few fine faint yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; firm; few thin very dark gray (10YR 3/1) clay films on faces of peds and lining tubular pores; about 4 percent coarse fragments; medium acid; clear wavy boundary.

Bt3—30 to 36 inches; olive gray (5Y 4/2) loam; common fine prominent yellowish brown (10YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; common thin black (10YR 2/1) clay films lining tubular pores; about 3 percent coarse fragments; neutral; clear wavy boundary.

C—36 to 60 inches; olive gray (5Y 5/3) loam; common fine prominent light olive brown (2.5Y 5/6) mottles; massive; friable; about 5 percent coarse fragments; irregularly shaped light gray (10YR 7/2) segregated lime filaments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 28 to 44 inches. Coarse fragments of gravel size make up 2 to 8 percent, by volume, of all horizons.

The A horizon has value of 2 through 5 and chroma of 1 or 2. It is typically loam, but the range includes fine sandy loam and sandy loam. Reaction is medium acid to neutral.

The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 1 through 3. It is loam, clay loam, or sandy clay loam. Clay films are thin to thick and few to many. Reaction ranges from medium acid in the upper part to neutral in the lower part.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 through 4. It is loam, sandy loam, or fine sandy loam. It is mildly alkaline or moderately alkaline.

Storden Series

The Storden series consists of deep, well drained, moderately permeable soils on ground and end moraines. The soils formed in calcareous, loamy glacial till. Slopes range from 6 to 18 percent.

Storden soils are similar to Ves soils and are adjacent to them on the landscape. Ves soils are deeper to carbonates.

Typical pedon of Storden loam, in an area of Ves-Storden loams, 6 to 12 percent slopes, 1,400 feet north and 1,185 feet east of the southwest corner of sec. 12, T. 126 N., R. 35 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—7 to 16 inches; yellowish brown (10YR 5/4) loam; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2—16 to 60 inches; light olive brown (2.5Y 5/4) loam; few medium distinct dark yellowish brown (10YR 4/4) and olive (5Y 4/4) mottles; massive; friable; fine irregularly shaped light gray (2.5Y 7/2) lime filaments and soft masses; about 2 percent coarse fragments; slight effervescence; mildly alkaline.

The solum is 7 to 10 inches thick.

The A horizon has value of 4 or 5 and chroma of 2 or 3. In a few pedons there is a B horizon that is as much as 4 inches thick. The C horizon has chroma of 2 through 6.

Sunburg Series

The Sunburg series consists of deep, well drained soils on ground and end moraines. Permeability is moderately rapid. The soils formed in calcareous, loamy glacial till. Slopes range from 12 to 25 percent.

Sunburg soils are adjacent to Koronis soils. Koronis soils have an argillic horizon. They and Sunburg soils are in similar positions on the landscape.

Typical pedon of Sunburg loam, in an area of Koronis-Sunburg complex, 12 to 25 percent slopes, 2,600 feet east and 2,300 feet south of the northwest corner of sec. 31, T. 122 N., R. 32 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; common roots; about 7 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

Ck—9 to 17 inches; yellowish brown (10YR 5/4) fine sandy loam; weak medium platy structure parting to weak medium subangular blocky; very friable; few masses of lime; about 12 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

C—17 to 60 inches; yellowish brown (10YR 5/4) fine sandy loam; common medium distinct grayish brown (10YR 5/2) relict mottles; weak medium platy structure; very friable; about 10 percent coarse fragments; slight effervescence; mildly alkaline.

The solum and the A horizon are coextensive. The solum is 7 to 10 inches thick.

The A horizon has value of 3 or 4 and chroma of 1 through 3. It is loam, fine sandy loam, or sandy loam. It

ranges from slightly effervescent to strongly effervescent.

The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 3 or 4. It is loam, fine sandy loam, or sandy loam.

Tara Series

The Tara series consists of deep, moderately well drained, moderately permeable soils on silt-mantled ground moraines. The soils formed in silty sediment overlying calcareous, loamy glacial till. Slopes range from 1 to 3 percent.

Tara soils are similar to Normania soils and commonly are adjacent to Doland, Flom, and Normania soils. Normania soils do not have an upper silty mantle. They and Tara soils are in similar positions on the landscape. Doland soils are upslope. Flom soils are downslope.

Typical pedon of Tara silt loam, 860 feet west and 90 feet south of the northeast corner of sec. 8, T. 123 N., R. 32 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common roots; slightly acid; abrupt smooth boundary.

A—8 to 16 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few roots; slightly acid; clear wavy boundary.

AB—16 to 23 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few roots; neutral; clear wavy boundary.

Bw1—23 to 29 inches; dark grayish brown (10YR 4/2) silt loam; weak fine subangular blocky structure; friable; few roots; neutral; clear wavy boundary.

Bw2—29 to 35 inches; olive brown (2.5Y 4/4) silt loam; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

2C—35 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles; massive; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 36 inches. The silty mantle is 25 to 35 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2.

The B horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2 or 3. Reaction ranges from neutral to mildly alkaline.

The 2C horizon has value of 5 or 6 and chroma of 2 through 4. It is loam or clay loam. It is mildly alkaline or moderately alkaline.

Vallers Series

The Vallers series consists of deep, poorly drained soils on ground moraines. Permeability is moderately slow. The soils formed in calcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Vallers soils are adjacent to Cathro, Flom, and Glencoe soils. Cathro and Glencoe soils are in depressions. Flom soils and Vallers soils are in similar positions on the landscape.

Typical pedon of Vallers loam, 1,690 feet south and 150 feet east of the northwest corner of sec. 8, T. 125 N., R 34 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

A—8 to 15 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; about 2 percent coarse fragments; few roots; violent effervescence; moderately alkaline; clear wavy boundary.

Bgk—15 to 30 inches; grayish brown (2.5Y 5/2) loam; few fine faint light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; few roots; about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

C—30 to 60 inches; olive gray (5Y 5/2) loam; few medium prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; massive; friable; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 50 inches. The thickness of the mollic epipedon ranges from 12 to 18 inches.

The A horizon has value of 2 or 3 and chroma of 1, or it is neutral in hue and has chroma of 0.

The B horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It has few to many mottles that have chroma of 4 through 6. The B horizon is loam or clay loam. Reaction is mildly alkaline or moderately alkaline.

The C horizon has colors similar to those of the B horizon. Reaction is mildly alkaline or moderately alkaline.

Ves Series

The Ves series consists of deep, well drained, moderately permeable soils on ground and end moraines. The soils formed in loamy glacial till. Slopes range from 2 to 25 percent.

Ves soils are similar to Normania soils and commonly are adjacent on the landscape to Flom and Storden soils. Normania soils have mottles that have chroma of 2 or less within 40 inches of the surface. Storden soils and Ves soils are in similar positions. Flom soils are downslope.

Typical pedon of Ves loam, 2 to 6 percent slopes (fig. 13), 2,120 feet north and 60 feet west of the southeast corner of sec. 9, T. 125 N., R. 34 W.

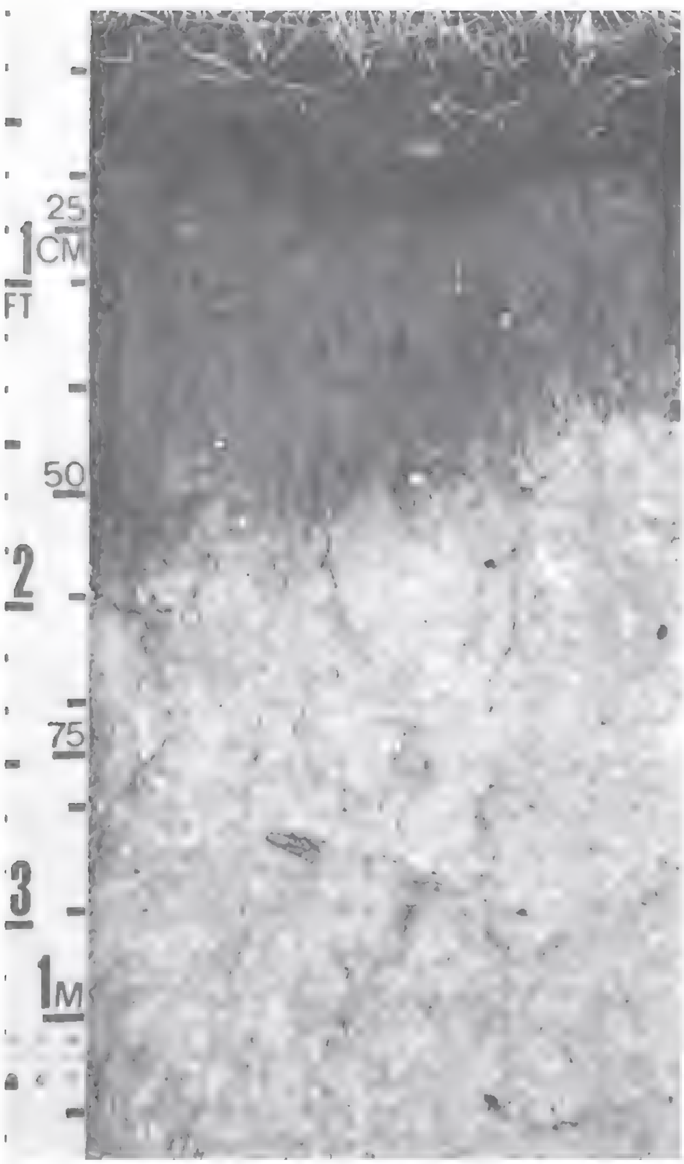


Figure 13.—Profile of Ves loam, 2 to 6 percent slopes. The soft, white nodules and threads in the upper part of the underlying material are accumulations of carbonates.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; about 3 percent coarse fragments; slightly acid; abrupt smooth boundary.

AB—8 to 12 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

Bw—12 to 26 inches; dark brown (10YR 4/4) loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

Ck—26 to 34 inches; light olive brown (2.5Y 5/4) loam; weak medium subangular blocky structure; friable; many fine irregular white (10YR 8/2) lime threads and masses; about 5 percent coarse fragments; violent effervescence; moderately alkaline; gradual smooth boundary.

C—34 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct grayish brown (10YR 5/2) mottles; massive; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 35 inches. The mollic epipedon ranges from 10 to 16 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Reaction is neutral or slightly acid.

The B horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 3 or 4. Reaction is slightly acid or neutral.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is mildly alkaline or moderately alkaline.

Watab Series

The Watab series consists of deep, somewhat poorly drained soils. Permeability is rapid in the upper part and moderately slow in the lower part. The soils are on ground moraines on the border of outwash plains and valley trains. They formed in a sandy mantle and in noncalcareous, loamy glacial till. Slopes range from 1 to 2 percent.

Watab soils are similar to Brainerd soils and commonly are adjacent on the landscape to Brainerd, Langola, Nokay, and Pomroy soils. Brainerd soils developed in loamy material. Brainerd and Langola soils are upslope from Watab soils; Nokay soils are downslope. Pomroy soils are more sloping than Watab soils.

Typical pedon of Watab loamy fine sand, 760 feet south and 1,610 feet east of the northwest corner of sec. 28, T. 125 N., R. 28 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loamy fine sand dark gray (10YR 4/1) dry; weak medium crumb structure; very friable; slightly acid; abrupt smooth boundary.

E1—9 to 14 inches; dark grayish brown (10YR 4/2) loamy fine sand; common medium distinct dark yellowish brown (10YR 4/4) and very dark brown (10YR 2/2) mottles; weak medium and thin platy structure; very friable; medium acid; clear wavy boundary.

E2—14 to 20 inches; brown (10YR 5/3) fine sand; many medium prominent yellowish brown (10YR 5/6) and reddish brown (5YR 4/4) mottles; weak medium platy structure parting to weak fine subangular blocky; very friable; medium acid; clear smooth boundary.

2Bw1—20 to 24 inches; brown (10YR 5/3) gravelly fine sandy loam; many medium distinct yellowish brown (10YR 5/8) and dark brown (7.5YR 3/2) mottles; weak medium subangular blocky structure; in lower part, about 20 percent subrounded and rounded coarse fragments that are mainly 1 inch to 3 inches across; strongly acid; clear wavy boundary.

2Bw2—24 to 34 inches; dark brown (7.5YR 4/4) sandy loam; many medium and coarse prominent reddish brown (5YR 6/2) mottles; moderate medium subangular blocky structure; friable; about 10 percent coarse fragments; common brown (7.5YR 5/4) sand coatings on faces of some peds; medium acid; clear wavy boundary.

2Bx—34 to 44 inches; dark brown (7.5YR 4/4) sandy loam; many medium distinct strong brown (7.5YR 5/6) and dark brown (7.5YR 4/2) mottles; moderate medium platy structure that parts to weak medium subangular blocky; firm; about 10 percent coarse fragments; few thin dark brown (7.5YR 3/2) clay films on faces of some peds; slightly acid; clear irregular boundary.

2Cx—44 to 60 inches; dark brown (7.5YR 4/4) sandy loam; weak medium platy structure; firm; about 10 percent coarse fragments; neutral.

The thickness of the solum ranges from 36 to 56 inches, and the depth to the fragipan ranges from 20 to 42 inches. The upper horizons in the sandy mantle have no coarse fragments; coarse fragments of gravel size commonly range from 10 to 20 percent, by volume, in the 2B and 2C horizons.

The A or Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is loamy fine sand, loamy sand, fine sandy loam, or sandy loam.

The E horizon has value of 4 or 5 and chroma of 2 or 3. It is loamy fine sand, loamy sand, fine sand, or sand. The E horizon has distinct or prominent mottles.

The 2Bw horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 through 4. It is gravelly fine sandy loam, loamy fine sand, loamy sand, sand, or fine sand and grades in the lower part to sandy loam or fine sandy loam.

The 2Bx and 2Cx horizons have hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. The 2Bx and 2Cx horizons are sandy loam or fine sandy loam. They range from medium acid to neutral.

Waukon Series

The Waukon series consists of deep, well drained, moderately permeable soils on ground and end moraines. The soils formed in loamy glacial till. Slopes range from 2 to 18 percent.

Waukon soils are similar to Nebish soils and are adjacent on the landscape to Bluffton, Cordova, and Gonvick soils. Nebish soils have a thinner A horizon and a more fully developed B horizon than Waukon soils. Bluffton soils are in depressions. Cordova soils are in depressions and drainageways. Gonvick soils are downslope from Waukon soils.

Typical pedon of Waukon loam, 12 to 18 percent slopes, 190 feet east and 720 feet north of the southwest corner of sec. 31, T. 127 N., R. 34 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

Bt1—7 to 14 inches; dark brown or brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; friable; many thick very dark brown (10YR 2/2) continuous clay films on faces of peds; about 2 percent coarse fragments; neutral; clear wavy boundary.

Bt2—14 to 28 inches; yellowish brown (10YR 5/4) loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; many thick dark brown (7.5YR 3/2) continuous clay films on faces of peds; about 2 percent coarse fragments; neutral; gradual wavy boundary.

C1—28 to 35 inches; light olive brown (2.5Y 5/4) loam; common medium prominent yellowish brown (10YR 5/8) and reddish brown (5YR 4/4) mottles; massive; friable; about 3 percent coarse fragments; few light gray lime threads; strong effervescence; mildly alkaline; gradual irregular boundary.

C2—35 to 60 inches; yellowish brown (10YR 5/4) loam; few medium prominent dark red (2.5YR 3/6) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 40 inches.

The A or Ap horizon has value of 2 or 3 and chroma of 1 or 2. The A horizon is loam, sandy loam, or clay loam. In some uncultivated areas there is an E horizon that is as much as 5 inches thick.

The B horizon has value of 4 or 5 and chroma of 3 or 4. It is clay loam, loam, or sandy clay loam. It is slightly acid to mildly alkaline.

The C horizon has hue of 2.5Y or 10YR, value of 5 or 6, and chroma of 3 or 4. It is loam, sandy loam, or light clay loam. It is mildly alkaline or moderately alkaline.

Formation of the Soils

Soil forms through the physical and chemical weathering of deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

The following paragraphs relate the factors of soil formation to the soils in the survey area.

Parent Material

The soils of Stearns County formed mostly in glacial till or in material that was sorted out of the till by the action of water. About 63 percent of the soils formed in glacial till, and about 37 percent formed in or over sandy and gravelly outwash sediments. The Wadena, Superior, Rainy, and Des Moines lobes of the Wisconsin glaciation were the most recent of the glaciers that covered parts of the county (*5, 11*). The following paragraphs describe the parent material as it occurs within major geomorphic areas in the county (fig. 14).

St. Croix moraine—This end moraine of the Rainy lobe is in the eastern part of the county and traverses the county in a northwest-southeast direction. The landscape is rolling and hilly. Most of the till is sandy loam. The soils that formed in this drift belong mainly to the Cushing, DeMontreville, Alstad, Mahtomedi, and Jewett series. Several distinctive geomorphic land forms occur on the St. Croix moraine. These include ice-walled lake plains, collapsed stream sediments, and dead-ice moraines.

The ice-walled lake plains consist of flat-topped hills that typically are the highest part of the landscape. Stratified silty sediments are on the nearly level and gently sloping hilltops. These sediments are probably of lacustrine origin and were deposited in the temporary lakes that formed during glacial melt periods (*3*). Only the Jewett soils formed on this landscape.

Collapsed stream sediments are evident in random, inconsistent pockets of sand and gravel and stony spots, which occur at different elevations in the landscape. In some places these sediments mantle the hilltops, and in other places they mantle the side slopes or lower slopes. These sediments are remnants of small, meandering streambeds, which carried flowing water on top of the glacial ice or through crevices in the glacial ice. As the glacial ice melted, the sediments were deposited on the sand and gravel materials. The Chetek and Mahtomedi soils formed on this part of the landscape.

Dead-ice moraines are characterized by their complexity of slope. In these areas the glacial ice was blanketed by superglacial till (*3*). This till had a high water content derived from melting ice. Wherever the till blanket was thin, the dead ice melted more rapidly; the consequent slumping and flowing of the superglacial till created an irregular, complex topography. Cushing and DeMontreville soils are predominant on the dead-ice moraines.

Melt water channels and outwash plains—Gravelly melt water channels and outwash plains form a network throughout the county. They formed mostly through the action of streams flowing off the receding glacial ice. Outwash material was deposited on large, continuous terraces along most of the major streams and in pockets or in layers over the glacial till on uplands throughout the county. The major outwash deposits in the county are the Mississippi River Valley along the eastern border; the Sauk River Valley, which transects the county from northwest to east; and the Crow River Valley in the southwestern part of the county. The Mississippi River Valley, also called the Green Prairie Terrace, is made up primarily of soils that formed in loamy sediment 10 to 20 inches thick and in the underlying sandy and gravelly sediment. These sediments originated from the Wadena and Rainy lobes when the waters of glacial Lakes Wadena and Randall emptied into the Sauk Valley Lowland and left the county via the Horseshoe Lake chain valley. Hubbard, Dickman, and Duelm soils formed in this material. The soils in the Sauk River Valley, also called the Sauk Valley Lowland, formed in similar material that originated from the same source as that of the soils of the Mississippi River Valley (*7*). The Sauk River Valley consists mainly of Hubbard, Dickman, Estherville, and Osakis soils. The Crow River Valley, better known today as Bonanza Valley, is made up primarily of soils that formed in loamy sediment 10 to 20 inches thick and in the underlying sandy and gravelly sediment. These sediments were deposited by melt water that flowed from the receding ice of the Alexandria moraine, which forms rolling and steep hills in the Lake Koronis area in the southern part of the county.

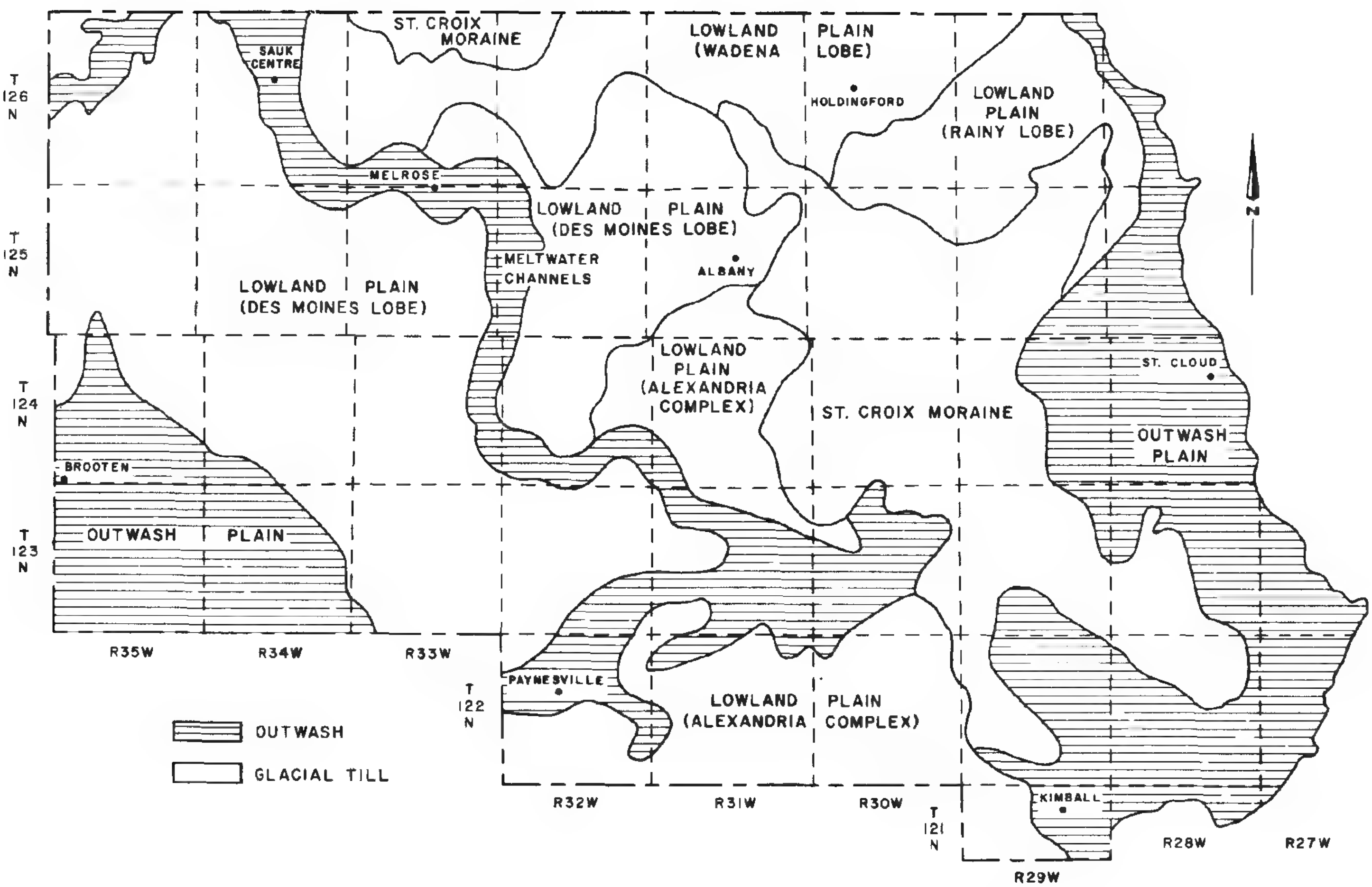


Figure 14.—Parent material and the major geomorphic areas in Stearns County.

Estherville, Osakis, and Regal soils formed in this material.

Lowland plain—The lowland plain is a glacial ground moraine or till plain that was formed from glacial drift from 4 different lobes—or invasions of glaciers—of the Wisconsin Glaciation during the Pleistocene epoch. The Wadena, Superior, and Rainy lobes entered Stearns County during the middle Cary subage, about 35,000 years ago. The Wadena lobe entered the county first from a northerly direction and deposited calcareous, sandy loam or loam, yellowish brown till that commonly does not contain shale fragments. Somewhat later, the Superior lobe entered the county from the east and reached the St. Croix moraine at its maximum advance westward. It deposited neutral, reddish sandy loam till. This material can be observed only in deep road cuts and as smears in other glacial material. The Superior lobe was overridden by the Rainy lobe, which entered the county from a northeasterly direction and overrode most of the St. Croix moraine before terminating its southwestern movement. It deposited neutral, brown sandy loam till. The fourth invasion of ice came from the northwest during the late Cary subage about 14,000 years ago. It covered most of Stearns County west of the St. Croix moraine and deposited calcareous, olive brown loam and clay loam till that is rich in shale. Other glaciers left glacial deposits in the county during earlier glacial periods, but little or no evidence of these events can be observed (*7, 8, 12*). The lowland plain in the northeastern part of the county is a ground moraine that appears to be a subdued drumlin field in places. The till is of Rainy lobe origin and has relative relief of 5 to 20 feet. It contains an abundance of dark-colored coarse fragments, cobbles, and stones. Flak, Brainerd, and Nokay soils formed in this material. In the northern part of the county, there is a ground moraine of Wadena lobe origin that has definite drumlin features in its eastern part near Holdingford. It is sandy loam till that has an abundance of dark-colored coarse fragments, cobbles, and stones. Relief varies from 5 to 50 feet. Holdingford,

Growton, Nebish, and Beltrami soils formed in this material. The lowland plain in the western part of the county is a ground moraine consisting almost entirely of irregularly shaped low knolls and nearly level flats, which rise 1 foot to 10 feet above the floor of the till plain. Normania, Flom, Roliss, and Ves soils formed in this material west of the Sauk River. Waukon and Gonvick soils formed in the area east of the Sauk River. In the southern part of the county, the lowland plain borders the Alexandria moraine and includes a small part of it. The till is thought to be a mixture of Wadena lobe and Des Moines lobe material that originated when the Des Moines lobe moved in from the west and overrode the Alexandria moraine, mixing together the two till materials and depositing a till that has characteristics of both. Koronis and Marcellon soils formed in this material.

Climate

Stearns County has a subhumid to humid, continental climate that is characterized by cold winters and generally mild summers. The climate has had a pronounced effect on soil formation. When the soil is frozen in winter, the soil-forming processes are slowed. The alternation of freezing and thawing, especially in spring, plays a part in the development of soil structure. It also helps to disintegrate some of the material. Rainfall affects the leaching of lime. The depth to which free lime has been leached has largely determined the thickness of the solum in soils that formed in calcareous parent material.

Climate was responsible to a large extent for the kind of vegetation that grew here in the past. Soils that formed under prairie vegetation have a dark surface layer, while soils that formed under forest vegetation have a lighter colored surface layer. Prairie vegetation and cool temperatures promote the accumulation of organic matter. Forest vegetation and cool temperatures also promote the accumulation of organic matter, but to a lesser degree because the network of root systems near the soil surface is not so close and extensive. Most of the soils have a high or medium content of organic matter. More details about the climate are given in the section "General Nature of the County."

Plant and Animal Life

The native vegetation of Stearns County in the western part consisted mainly of tall and mid prairie grasses, depending on the soil, the drainage, and other site factors. Prairie cordgrass, reedgrass, switchgrass, and sedges grew on wet sites. Bluestem, green needlegrass, porcupinegrass, Canada wildrye, indiangrass, needleandthread, and sideoats grama grew on the better drained sites. A variety of native flowers flourished on the prairie, including aster, goldenrod, sunflowers, blazing star, clover, rose, lily, harebell, phlox, and gentian (*6*).

The native vegetation in the eastern part consisted primarily of deciduous trees, but there were also a few relic stands of conifers. The tree species in Stearns County today are mainly the same as those that made up the original forests. Bur oak, northern red oak, white oak, green ash, canoe birch, American elm, slippery elm, American basswood, boxelder, red maple, sugar maple, silver maple, and hophornbeam grow on the better drained sites. Willow, alder, cottonwood, aspen, yellow birch, and tamarack grow on the wet sites. Relic groves of white, red, and jack pines, black spruce, and northern white-cedar were observed by early settlers in the county.

The growth of plants in freshly deposited glacial till started soil formation in Stearns County. Plant roots loosen the soil and bring minerals up from the parent material. The plants die and decay, thus returning plant nutrients to the soil and providing organic matter for further soil development.

Earthworms have great influence on soil formation. The subsurface horizon of many soils contains wormcasts of surface and subsoil material. Burrowing animals also mix soil material from various horizons and bring fresh parent material to the surface.

Man influences soil formation. Farming has affected some of the soil-forming processes. Erosion of the surface layer has accelerated on some of the sloping soils. Some of the soils in lower lying areas have gained deposits of eroded material. The granular structure of the surface layer has been weakened or destroyed in many soils. The surface layer of most of the well drained soils has become browner as a result of mixing with the subsoil and of reduction of the content of organic matter. Leaching has been slowed in many soils as a result of increased runoff and reduced infiltration. Man's activities, particularly in altering drainage conditions, maintaining fertility, and changing the kinds of vegetation, continue to have an important effect on soil formation.

Relief

In Stearns County relief ranges from nearly level to steep. Relief is the most important factor differentiating soils that form in uniform parent material. Soils that have a fairly mature profile, in which the horizons are distinct, formed where drainage is good and the slope is gentle. Steep soils show less evidence of soil formation, mainly because runoff is excessive. Runoff reduces the amount of water that can leach the soil and the amount that plants can use. Many steep soils, therefore, are droughty, have indistinct horizons, and support a poor cover of plants.

Topographic position is a key to the kind of soil and the soil drainage class at any place on the landscape. For example, it is normally possible to predict the location of Ves, Normania, Flom, Roliss, and Glencoe soils, which make up the Ves drainage sequence. Each

of these soils occupies a distinctive part of the landscape. The well drained Ves soils are on gentle convex and concave slopes and on knolls; the moderately well drained, nearly level Normania soils are at a lower elevation than Ves soils; the poorly drained Flom and Roliss soils are in drainageways and on nearly level, wet flats; and the very poorly drained Glencoe soils are in depressions and very wet drainageways.

Time

The time required for soil formation depends to a large extent on the other factors. In areas where relief and drainage are favorable, enough time has elapsed for the soils to have mature profiles. Steep soils have immature or thin profiles because the soil-forming processes have been comparatively ineffective. Soils that formed in alluvium along streams are immature and weakly developed because the material is young. Fresh deposits of alluvium are added almost annually, and distinct, mature horizons have not had time to form.

In the geological sense, all of the soils in the county are very young. In most parts of the county, soil-forming processes have been active probably for only about 8,000 to 12,000 years.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vols., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Clayton, L., and T. Freers. Glacial geology of the Missouri Coteau and adjacent areas. North Dakota Geol. Surv. Misc. Ser. 30, 170 pp., illus.

(4) Helgesen, J.O., D.W. Erickson, and G.F. Lindholm. 1975. Water resources of the Mississippi and Sauk Rivers Watersheds, central Minnesota. U.S. Geol. Surv., Hydro. Invest., Atlas HA-534.

(5) Lindholm, G.F., D.F. Farrell, and J.O. Helgesen. 1974. Water resources of the Crow River Watershed, south central Minnesota. U.S. Geol. Surv., Hydro. Invest., Atlas HA-528.

(6) Marschner, Francis J. 1930. The original vegetation of Minnesota. U.S. Dept. of Agric., North Central For. Exp. Stn., illus.

(7) Schneider, A.F. 1956. Pleistocene geology of central Minnesota. *In* Geol. Soc. of Am. Guidebook, Mpls. Meeting. U.S. Geol. Soc., illus.

(8) Thiel, George A. 1947. Geology and underground waters of northeastern Minnesota. Minn. Geol. Surv. Bull. 32. 247 pp., illus.

(9) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(10) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(11) Woyski, M.S. 1949. Intrusives of central Minnesota. Geological Soc. of Am. Bull. 60: 999-1016, illus.

(12) Wright, H.E., Jr. 1972. Quaternary history of Minnesota. *In* Geology of Minnesota: a centennial volume. Minn. Geol. Surv. pp. 515-547, illus.

Glossary

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots.

When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A

soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has

the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded and 6 to 15 inches (15 to 38 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. Includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by melt water streams, in a glacial lake or other body of still water in front of a glacier.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber. Page start for tables - 171

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-75 at Collegeville, Minnesota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	18.4	0.1	9.2	43	-29	0	0.95	0.31	1.45	3	10.7
February---	24.8	5.4	15.1	47	-24	0	.88	.22	1.40	3	8.3
March------	35.4	17.0	26.3	62	-17	10	1.47	.57	2.19	4	11.8
April------	53.1	33.2	43.2	83	12	35	2.35	1.12	3.34	5	2.6
May--------	67.9	45.5	56.8	90	27	234	3.64	2.00	4.97	7	.1
June-------	76.9	55.5	66.2	94	39	486	4.47	2.42	6.14	8	.0
July-------	81.7	60.4	71.1	94	46	654	3.00	1.43	4.28	7	.0
August-----	79.5	58.5	69.1	94	44	592	4.44	2.69	6.01	7	.0
September--	68.8	48.6	58.8	88	30	271	2.84	1.28	4.10	6	.0
October----	58.9	39.2	49.1	82	19	113	2.02	.62	3.13	4	.4
November---	39.3	23.8	31.6	65	-4	0	1.31	.53	1.94	3	4.9
December---	25.2	8.9	17.1	47	-22	0	.92	.27	1.42	3	9.2
Year-----	52.5	33.0	42.8	96	-29	2,395	28.29	23.51	32.85	60	48.0

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-75 at Collegeville, Minnesota]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 27	May 9	May 20
2 years in 10 later than--	April 23	May 4	May 15
5 years in 10 later than--	April 14	April 26	May 6
First freezing temperature in fall:			
1 year in 10 earlier than--	October 11	October 4	September 20
2 years in 10 earlier than--	October 16	October 9	September 25
5 years in 10 earlier than--	October 27	October 19	October 6

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-75 at Collegeville, Minnesota]

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	178	158	132
8 years in 10	184	164	138
5 years in 10	195	176	152
2 years in 10	206	187	165
1 year in 10	212	193	172

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
5A	Dakota loam, 0 to 2 percent slopes	1,000	0.1
5B	Dakota loam, 2 to 6 percent slopes	1,915	0.2
7A	Hubbard loamy sand, 0 to 2 percent slopes	8,750	1.0
7B	Hubbard loamy sand, 2 to 6 percent slopes	16,075	1.8
7C	Hubbard loamy sand, 6 to 12 percent slopes	2,530	0.3
25	Becker fine sandy loam	310	*
32B	Nebish sandy loam, 2 to 8 percent slopes	17,420	2.0
32C	Nebish sandy loam, 8 to 15 percent slopes	13,900	1.6
32E	Nebish sandy loam, 15 to 25 percent slopes	6,690	0.7
32F	Nebish sandy loam, 25 to 40 percent slopes	1,700	0.2
35	Blue Earth mucky silt loam	1,750	0.2
36	Flom loam	39,515	4.5
38B	Waukon loam, 2 to 6 percent slopes	23,090	2.6
38C	Waukon loam, 6 to 12 percent slopes	6,500	0.7
38D	Waukon loam, 12 to 18 percent slopes	1,205	0.1
41A	Estherville sandy loam, 0 to 2 percent slopes	23,240	2.6
41B	Estherville sandy loam, 2 to 6 percent slopes	15,060	1.7
41C	Estherville sandy loam, 6 to 12 percent slopes	1,915	0.2
69B	Fedji loamy sand, 2 to 6 percent slopes	2,130	0.2
72	Shooker loam	1,160	0.1
75	Bluffton loam	2,860	0.3
109	Cordova loam	26,290	3.0
114	Glencoe loam	7,870	0.9
119B	Pomroy fine sand, 1 to 8 percent slopes	2,220	0.2
125	Beltrami loam	9,830	1.1
129	Cylinder loam	1,490	0.2
133B	Dalbo loam, 2 to 8 percent slopes	420	*
142	Nokay fine sandy loam	2,515	0.3
144B	Flak sandy loam, 4 to 8 percent slopes	3,690	0.4
144C	Flak sandy loam, 8 to 15 percent slopes	2,220	0.2
144E	Flak sandy loam, 15 to 25 percent slopes	1,465	0.2
155B	Chetek sandy loam, 1 to 6 percent slopes	2,480	0.3
156A	Fairhaven loam, 0 to 2 percent slopes	4,470	0.5
156B	Fairhaven loam, 2 to 6 percent slopes	3,780	0.4
159B	Anoka loamy sand, 2 to 8 percent slopes	970	0.1
163B	Brainerd fine sandy loam, 1 to 4 percent slopes	12,820	1.4
179B	Langola loamy sand, 1 to 4 percent slopes	1,610	0.2
180A	Gonvick loam, 1 to 2 percent slopes	9,055	1.0
180B	Gonvick loam, 2 to 4 percent slopes	23,170	2.8
181	Litchfield loamy sand	4,280	0.5
183	Dassel sandy loam	3,000	0.3
200B	Holdingford sandy loam, 4 to 8 percent slopes	10,165	1.1
200C	Holdingford sandy loam, 8 to 15 percent slopes	2,860	0.3
204B	Cushing sandy loam, 2 to 8 percent slopes	23,025	2.6
204C	Cushing sandy loam, 8 to 15 percent slopes	16,000	1.8
204E	Cushing sandy loam, 15 to 25 percent slopes	10,300	1.2
207B	Nymore loamy sand, 2 to 8 percent slopes	3,360	0.4
207C	Nymore loamy sand, 8 to 15 percent slopes	2,840	0.3
207E	Nymore loamy sand, 15 to 25 percent slopes	2,410	0.3
218	Watab loamy fine sand	1,680	0.2
233B	Growton sandy loam, 1 to 4 percent slopes	8,580	1.0
236	Vallers loam	14,350	1.6
255	Mayer loam	3,805	0.4
260	Duelm loamy sand	5,365	0.6
261	Isan loamy sand	1,940	0.2
281	Darfur coarse sandy loam	10,615	1.2
292B	Alstad sandy loam, 1 to 4 percent slopes	5,530	0.6
318	Mayer loam, depressional	3,240	0.4
325	Prebish sandy loam, depressional	2,600	0.3
327A	Dickman sandy loam, 0 to 2 percent slopes	9,430	1.1
327B	Dickman sandy loam, 2 to 6 percent slopes	8,940	1.0
392	Biscay loam	3,805	0.4
399	Biscay loam, depressional	2,080	0.2
406B	Dorset sandy loam, 2 to 8 percent slopes	7,920	0.9
406C	Dorset sandy loam, 8 to 15 percent slopes	2,150	0.2
406E	Dorset sandy loam, 15 to 25 percent slopes	1,015	0.1
413	Osakis loam	12,860	1.4
414	Hamel loam	4,560	0.5
421B	Ves loam, 2 to 6 percent slopes	10,470	1.2
421C	Ves loam, 6 to 12 percent slopes	3,620	0.4

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
446A	Normania loam, 1 to 3 percent slopes	25,105	2.8
446B	Normania loam, 3 to 5 percent slopes	27,600	3.1
453B	DeMontreville loamy sand, 2 to 8 percent slopes	5,555	0.6
453C	DeMontreville loamy sand, 8 to 15 percent slopes	1,915	0.2
454B	Mahtomedi loamy coarse sand, 2 to 8 percent slopes	4,470	0.5
454C	Mahtomedi loamy coarse sand, 8 to 15 percent slopes	4,700	0.5
454E	Mahtomedi loamy coarse sand, 15 to 25 percent slopes	3,080	0.3
454F	Mahtomedi loamy coarse sand, 25 to 40 percent slopes	725	0.1
459	Corunna loam	4,445	0.5
461B	Koronis loam, 2 to 6 percent slopes	18,820	2.1
461C	Koronis loam, 6 to 12 percent slopes	8,145	0.9
465	Kalmarville sandy loam, frequently flooded	5,485	0.6
511	Marcellon loam	6,480	0.7
525	Muskego muck	3,760	0.4
540	Seelyeville muck	21,110	2.4
541	Rifle mucky peat	8,275	0.9
543	Markey muck	13,855	1.6
544	Cathro muck	17,230	1.9
565	Eckvoll loamy sand	1,020	0.1
566	Regal loam	19,080	2.1
571	Coriff loam	3,900	0.4
572	Lowlein sandy loam	8,010	0.9
582	Roliss loam	27,095	3.0
591B	Doland silt loam, 1 to 6 percent slopes	2,550	0.3
597	Tara silt loam	2,245	0.3
611C	Hawick loamy sand, 6 to 12 percent slopes	11,310	1.3
611D	Hawick loamy sand, 12 to 40 percent slopes	7,780	0.9
639A	Ridgeport sandy loam, 0 to 2 percent slopes	1,695	0.2
639B	Ridgeport sandy loam, 2 to 6 percent slopes	2,320	0.3
804D	Koronis-Estherville complex, 12 to 25 percent slopes	1,820	0.2
807D	Koronis-Sunburg complex, 12 to 25 percent slopes	2,950	0.3
848	Urban land-Osakis complex	1,500	0.2
850	Urban land-Dassel complex	3,025	0.3
865B	Urban land-Hubbard complex, 1 to 8 percent slopes	2,860	0.3
873	Prebish-Nokay complex	4,350	0.5
875B	Estherville-Hawick complex, 2 to 6 percent slopes	15,260	1.7
954C	Ves-Storden loams, 6 to 12 percent slopes	1,020	0.1
954D	Ves-Storden loams, 12 to 18 percent slopes	535	0.1
999B	Ves-Estherville complex, 2 to 6 percent slopes	690	0.1
999C	Ves-Estherville complex, 6 to 12 percent slopes	1,525	0.2
999D	Ves-Estherville complex, 12 to 25 percent slopes	1,090	0.1
1013	Pits, quarry	150	*
1015	Psamments, sloping	1,370	0.2
1016	Udorthents, loamy	720	0.1
1018	Udifluvents, frequently flooded	1,065	0.1
1029	Pits, gravel	550	0.1
1055	Histosols and Haplaquolls, ponded	19,680	2.2
1064	Rock outcrop-Lithic Eutrochrepts complex	590	0.1
1805	Blue Earth Variant, mucky silt loam	1,320	0.1
1825C	Seelyeville muck, sloping	3,830	0.4
1828	Glencoe muck	2,030	0.2
1842F	Cushing and Flak sandy loams, steep	1,490	0.2
1843C	Cushing-DeMontreville complex, 8 to 15 percent slopes	1,000	0.1
1843E	Cushing-DeMontreville complex, 15 to 25 percent slopes	3,100	0.3
1879	Seelyeville muck, calcareous	1,720	0.2
1880	Martisco mucky silt loam	485	0.1
1892	Prebish fine sandy loam	6,195	0.7
1902B	Jewett silt loam, 2 to 8 percent slopes	1,325	0.1
	Water	33,280	3.7
	Total	892,160	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
5A------------------------ Dakota	82	24	65	3.5	3.0	5.0	---
5B------------------------ Dakota	78	22	60	3.4	3.0	5.0	---
7A------------------------ Hubbard	50	18	50	2.2	2.4	2.8	---
7B------------------------ Hubbard	40	13	40	2.2	2.4	2.7	---
7C------------------------ Hubbard	35	10	35	1.7	2.0	2.3	---
25------------------------ Becker	80	24	65	4.0	3.0	5.6	---
32B----------------------- Nebish	75	22	62	3.6	3.1	5.1	---
32C----------------------- Nebish	70	20	60	3.3	3.1	4.9	---
32E----------------------- Nebish	---	---	---	3.0	2.6	4.5	---
32F----------------------- Nebish	---	---	---	---	2.3	---	---
35------------------------ Blue Earth	75	22	60	3.0	---	4.5	6.0
36------------------------ Flom	95	28	86	4.4	3.8	6.0	---
38B----------------------- Waukon	85	25	75	4.0	3.9	5.8	---
38C----------------------- Waukon	80	23	65	3.5	3.3	4.9	---
38D----------------------- Waukon	70	20	55	3.0	3.1	4.4	---
41A----------------------- Estherville	50	17	40	2.0	3.0	3.0	---
41B----------------------- Estherville	45	15	35	2.0	2.5	2.9	---
41C----------------------- Estherville	32	11	30	1.4	2.0	2.0	---
69B----------------------- Fedji	60	25	55	3.0	2.7	4.4	---
72------------------------ Shooker	85	24	75	4.0	3.0	5.8	---
75------------------------ Bluffton	80	24	68	3.4	3.0	5.0	---
109----------------------- Cordova	90	27	75	4.0	3.8	6.0	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
114 Glencoe	85	25	70	3.5	3.2	5.2	---
119B Pomroy	60	18	50	3.0	3.0	4.5	---
125 Beltrami	80	25	80	4.0	3.5	6.0	---
129 Cylinder	80	25	75	3.7	3.3	5.5	---
133B Dalbo	82	24	70	3.8	3.5	5.6	---
142 Nokay	80	25	70	4.0	3.5	5.9	---
144B Flak	70	22	65	3.5	3.0	5.5	---
144C Flak	60	18	55	3.1	2.7	4.6	---
144E Flak	---	---	---	---	2.0	---	---
155B Chetek	55	16	50	2.4	2.2	3.5	---
156A Fairhaven	80	25	70	4.0	3.5	6.0	---
156B Fairhaven	75	24	68	3.9	3.3	5.9	---
159B Anoka	55	15	45	2.5	2.8	3.7	---
163B Brainerd	80	25	70	4.0	3.0	6.0	---
179B Langola	50	15	45	2.8	2.8	4.3	---
180A Gonvick	95	28	85	4.7	4.0	6.7	---
180B Gonvick	92	27	80	4.5	4.0	6.6	---
181 Litchfield	68	19	52	3.0	2.6	4.5	---
183 Dassel	72	21	62	3.0	2.8	4.5	---
200B Holdingford	85	25	76	4.2	3.0	6.0	---
200C Holdingford	75	22	68	4.0	2.9	6.0	---
204B Cushing	75	21	65	3.7	3.4	5.1	---
204C Cushing	60	18	55	3.2	3.0	4.6	---
204E Cushing	---	---	---	2.6	2.6	4.1	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
207B. Nymore	45	13	40	2.0	2.5	3.0	---
207C. Nymore	---	---	---	1.7	2.0	2.5	---
207E. Nymore	---	---	---	---	1.6	---	---
218. Watab	55	16	50	3.0	2.5	4.4	---
233B. Growton	80	24	70	4.3	3.4	6.3	---
236. Vallers	78	23	68	3.9	3.3	5.9	---
255. Mayer	80	24	66	3.9	3.2	5.9	---
260. Duelm	56	16	50	2.7	2.5	3.9	---
261. Isan	60	16	50	2.6	2.3	3.8	---
281. Darfur	85	23	66	3.1	2.8	4.6	---
292B. Alstad	80	24	75	4.0	3.6	6.0	---
318. Mayer	70	21	55	2.9	2.8	4.4	6.0
325. Prebish	65	18	52	3.2	3.0	4.7	---
327A. Dickman	50	15	50	2.5	2.1	3.7	---
327B. Dickman	48	14	48	2.5	2.1	3.7	---
392. Biscay	85	24	65	3.5	3.5	5.2	---
399. Biscay, depressional	75	22	60	3.0	3.0	4.5	6.0
406B. Dorset	65	19	52	2.5	2.0	3.7	---
406C. Dorset	55	16	48	2.2	1.5	3.3	---
406E. Dorset	---	---	---	---	1.0	---	---
413. Osakis	60	18	55	3.0	2.5	4.5	---
414. Hamel	90	27	80	4.3	3.8	6.0	---
421B. Ves	95	30	85	4.2	3.7	6.0	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
421C Ves	85	25	76	3.4	3.2	4.9	---
446A Normania	100	32	90	5.0	4.2	7.0	---
446B Normania	95	30	88	5.0	4.2	7.0	---
453B DeMontreville	60	18	60	3.0	2.5	4.5	---
453C DeMontreville	50	15	50	2.5	2.3	3.7	---
454B Mahtomedi	45	13	40	2.0	1.6	3.0	---
454C Mahtomedi	35	10	35	1.8	1.5	2.7	---
454E Mahtomedi	---	---	---	---	1.0	---	---
454F Mahtomedi	---	---	---	---	0.8	---	---
459 Corunna	85	25	80	4.0	3.6	5.9	---
461B Koronis	85	24	80	4.0	3.6	5.8	---
461C Koronis	75	25	70	3.5	3.2	5.2	---
465 Kalmarville	---	---	---	---	1.8	---	---
511 Marcellon	100	31	90	4.7	3.9	6.7	---
525 Muskego	60	18	55	2.9	---	4.4	6.0
540 Seelyeville	60	18	55	2.7	---	4.0	6.0
541 Rifle	55	16	50	2.5	---	3.7	6.0
543 Markey	60	18	55	2.5	---	3.7	6.0
544 Cathro	60	18	55	2.5	---	3.7	6.0
565 Eckvoll	70	21	65	3.5	3.2	5.1	---
566 Regal	75	23	75	3.0	2.7	4.5	---
571 Coriff	90	27	85	4.0	3.6	5.9	---
572 Lowlein	80	22	68	3.6	3.3	5.4	---
582 Roliss	80	24	75	3.7	3.4	5.5	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
591B------ Doland	90	27	84	4.1	3.7	6.1	---
597------ Tara	95	30	90	4.5	4.1	6.5	---
611C------ Hawick	30	10	35	2.1	1.8	3.0	---
611D------ Hawick	---	---	---	---	1.0	---	---
639A------ Ridgeport	60	20	55	2.2	1.7	3.6	---
639B------ Ridgeport	56	16	50	2.1	1.5	3.5	---
804D------ Koronis-Estherville	---	---	---	---	1.4	---	---
807D------ Koronis-Sunburg	---	---	---	---	1.5	---	---
848------ Urban land-Osakis	---	---	---	---	---	---	---
850------ Urban land-Dassel	---	---	---	---	---	---	---
865B------ Urban land-Hubbard	---	---	---	---	---	---	---
873------ Prebish-Nokay	71	23	64	3.7	3.3	5.4	---
875B------ Estherville-Hawick	41	12	37	2.4	2.1	3.6	---
954C------ Ves-Storden	70	21	70	3.0	2.8	4.7	---
954D------ Ves-Storden	60	17	60	2.7	2.5	4.2	---
999B------ Ves-Estherville	55	16	55	3.4	3.0	5.1	---
999C------ Ves-Estherville	50	15	50	2.9	2.8	4.5	---
999D------ Ves-Estherville	---	---	---	---	2.0	---	---
1013. Pits							
1015. Psamments							
1016. Udorthents							
1018. Udifluvents							
1029. Pits							

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
1055. Histosols and Aquolls	---	---	---	---	---	---	---
1064. Rock outcrop-Lithic Eutrochrepts	---	---	---	---	---	---	---
1805. Blue Earth Variant	65	20	60	2.7	---	4.5	6.0
1825C. Seelyeville	---	---	---	---	---	---	5.0
1828. Glencoe muck	75	21	75	3.5	3.1	5.2	5.5
1842F. Cushing and Flak	---	---	---	---	1.5	---	---
1843C. Cushing-DeMontreville	73	---	64	2.8	2.5	4.3	---
1843E. Cushing-DeMontreville	55	16	50	---	2.1	---	---
1879. Seelyeville	50	15	48	2.7	---	4.1	6.0
1880. Martisco	50	15	48	2.7	---	4.1	---
1892. Prebish	65	18	65	3.2	2.8	4.8	---
1902B. Jewett	80	24	75	3.8	3.4	5.6	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
7A, 7B, 7C Hubbard	3s	Slight	Slight	Severe	Slight	Red pine	56	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine	54	
						Jack pine	58	
						White spruce	54	
						Bur oak	40	
32B, 32C Nebish	2o	Slight	Slight	Slight	Slight	Red pine	60	Balsam fir, white spruce, eastern white pine.
						Eastern white pine	55	
						Quaking aspen	74	
						Jack pine	60	
						White spruce	59	
						American basswood	70	
						Northern red oak	64	
						Sugar maple	60	
32E, 32F Nebish	2r	Moderate	Moderate	Moderate	Slight	Red pine	60	Balsam fir, white spruce, eastern white pine.
						Eastern white pine	55	
						Quaking aspen	74	
						Jack pine	60	
						White spruce	59	
						American basswood	70	
						Northern red oak	64	
						Sugar maple	60	
38B, 38C Waukon	2o	Slight	Slight	Slight	Slight	Sugar maple	58	Red pine, eastern white pine, white spruce, jack pine.
						Eastern white pine	55	
						Red pine	60	
						White spruce	59	
38D Waukon	2r	Moderate	Moderate	Slight	Slight	Sugar maple	58	Red pine, eastern white pine, white spruce, jack pine.
						Eastern white pine	55	
						Red pine	60	
						White spruce	59	
72 Shooker	2w	Slight	Severe	Moderate	Moderate	Quaking aspen	72	White spruce, black spruce.
						White spruce	53	
						Black ash	45	
						American elm	50	
109 Cordova	3w	Slight	Moderate	Moderate	Slight	Eastern cottonwood	90	Green ash.
						American basswood	60	
						Green ash	52	
						Sugar maple	55	
119B Pomroy	2s	Slight	Slight	Moderate	Slight	Northern red oak	64	Jack pine, eastern white pine, red pine, white spruce.
						Red pine	60	
						Eastern white pine	55	
						Jack pine	64	
125 Beltrami	2o	Slight	Slight	Slight	Slight	Red pine	60	Red pine, white spruce, eastern white pine.
						Eastern white pine	55	
						Quaking aspen	74	
						Jack pine	64	
						White spruce	59	
						American basswood	70	
						Northern red oak	64	
						Sugar maple	60	

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
133B---------------- Dalbo	1o	Slight	Slight	Slight	Slight	Quaking aspen------- Northern red oak---- Red pine------------ Eastern white pine-- White spruce-------- American basswood--- Sugar maple---------	82 63 55 52 58 61 54	Red pine, white spruce, eastern white pine, balsam fir.
142----------------- Nokay	2o	Slight	Slight	Slight	Slight	Quaking aspen------- Sugar maple--------- American basswood--- Northern red oak----	75 60 65 65	White spruce, red pine.
144B, 144C---------- Flak	2d	Slight	Slight	Slight	Moderate	Northern red oak---- Red pine------------ Quaking aspen------- Eastern white pine-- American basswood--- Jack pine-----------	64 55 75 55 60 55	Red pine, white spruce, eastern white pine.
144E---------------- Flak	2d	Moderate	Moderate	Slight	Moderate	Northern red oak---- Red pine------------ Quaking aspen------- Eastern white pine-- American basswood--- Jack pine-----------	64 55 75 55 60 55	Red pine, white spruce, eastern white pine.
155B---------------- Chetek	3s	Slight	Slight	Moderate	Slight	Northern pin oak---- Jack pine----------- Black oak----------- White oak-----------	53 57 --- ---	Red pine, jack pine.
159B---------------- Anoka	3s	Slight	Slight	Moderate	Slight	Eastern white pine-- Northern pin oak----	55 55	Eastern white pine, jack pine, red pine.
163B---------------- Brainerd	2d	Slight	Slight	Moderate	Moderate	Northern red oak---- Quaking aspen------- American basswood--- Jack pine----------- Red pine------------ White spruce--------	64 70 60 55 55 50	Red pine, white spruce.
179B---------------- Langola	3s	Slight	Slight	Severe	Slight	Red pine------------ Eastern white pine-- Jack pine----------- White spruce--------	56 54 60 59	Red pine, white spruce.
180A, 180B---------- Gonvick	2o	Slight	Slight	Slight	Slight	Red pine------------ Quaking aspen------- Eastern white pine-- Jack pine----------- White spruce-------- American basswood--- Northern red oak---- Sugar maple---------	60 74 55 64 59 61 64 57	Red pine, white spruce, eastern white pine.
200B, 200C---------- Holdingford	2o	Slight	Slight	Slight	Slight	Northern red oak---- Quaking aspen------- Red pine------------ Eastern white pine-- Jack pine----------- White spruce-------- American basswood--- Sugar maple---------	64 74 60 55 64 59 61 57	Red pine, white spruce, eastern white pine, northern red oak.
204B, 204C---------- Cushing	2o	Slight	Slight	Slight	Slight	Sugar maple--------- Eastern white pine-- Red maple----------- American basswood--- Northern red oak----	60 --- --- --- 64	Eastern white pine, red pine, white spruce.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Trees to plant
204E: Cushing	2r	Moderate	Moderate	Moderate	Slight	Sugar maple	60	Eastern white pine, red pine, white spruce.
						Eastern white pine	---	
						Red maple	---	
						American basswood	---	
						Northern red oak	64	
207B, 207C: Nymore	3s	Slight	Slight	Moderate	Slight	Red pine	55	Red pine, white spruce, jack pine.
						Eastern white pine	55	
						Jack pine	60	
						White spruce	55	
207E: Nymore	3s	Moderate	Severe	Moderate	Slight	Red pine	55	Red pine, white spruce, jack pine.
						Eastern white pine	55	
						Jack pine	60	
						White spruce	55	
218: Watab	2d	Slight	Moderate	Moderate	Moderate	Quaking aspen	72	White spruce.
						White spruce	51	
						American basswood	62	
						Sugar maple	57	
233B: Growton	2o	Slight	Slight	Slight	Slight	Quaking aspen	75	Red pine, eastern white pine, white spruce.
						Eastern white pine	55	
						White spruce	59	
						Sugar maple	57	
						Red pine	60	
292B: Alstad	2o	Slight	Slight	Slight	Slight	Red maple	65	Eastern white pine, white spruce, black spruce.
						American basswood	---	
						American elm	---	
						Quaking aspen	---	
						Northern red oak	64	
406B, 406C: Dorset	3s	Slight	Slight	Moderate	Slight	Red pine	53	Eastern white pine, white spruce, red pine.
						Eastern white pine	52	
						Jack pine	60	
						Bur oak	45	
406E: Dorset	3s	Moderate	Moderate	Severe	Slight	Red pine	53	Eastern white pine, white spruce, red pine.
						Eastern white pine	52	
						Jack pine	60	
						Bur oak	45	
453B, 453C: DeMontreville	3s	Slight	Slight	Moderate	Slight	Red pine	56	Red pine, white spruce, jack pine.
						Eastern white pine	54	
						Jack pine	60	
						White spruce	57	
454B, 454C: Mahtomedi	3s	Slight	Slight	Severe	Slight	Red pine	55	Red pine, white spruce, jack pine.
						White spruce	57	
						Jack pine	60	
						Eastern white pine	55	
454E, 454F: Mahtomedi	3s	Moderate	Moderate	Severe	Slight	Red pine	55	Red pine, white spruce, jack pine.
						White spruce	57	
						Jack pine	60	
						Eastern white pine	55	
461B, 461C: Koronis	2o	Slight	Slight	Slight	Slight	Northern red oak	69	Black walnut, northern red oak, silver maple, white oak, eastern white pine, white spruce.
						American basswood	69	
						Sugar maple	64	
						Black walnut	62	
						Eastern white pine	64	
						Eastern redcedar	39	
						White oak	62	

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordi-nation symbol	Management concerns: Erosion hazard	Management concerns: Equip-ment limita-tion	Management concerns: Seedling mortal-ity	Management concerns: Wind-throw hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
525---------------- Muskego	3w	Slight	Severe	Severe	Severe	Tamarack------------ Red maple----------- Green ash----------- Black willow-------- Quaking aspen------- Silver maple--------	50 51 52 --- 56 ---	Tamarack, northern white-cedar, black spruce.
540---------------- Seelyeville	4w	Slight	Severe	Severe	Severe	Black spruce-------- Tamarack------------	23 36	Tamarack, northern white-cedar, black spruce.
541---------------- Rifle	5w	Slight	Severe	Severe	Severe	Balsam fir---------- Northern white-cedar Black ash----------- Tamarack------------ American basswood--- Paper birch--------- Black spruce--------	40 --- --- --- --- --- ---	Tamarack, northern white-cedar, black spruce.
543---------------- Markey	5w	Slight	Severe	Severe	Severe	Quaking aspen------- Balsam fir---------- Black spruce-------- Tamarack------------ Black ash----------- Northern white-cedar Paper birch---------	45 --- --- --- --- --- ---	Tamarack, northern white-cedar, black spruce.
544---------------- Cathro	5w	Slight	Severe	Severe	Severe	Balsam fir---------- Northern white-cedar Tamarack------------ American basswood--- Red maple----------- Black spruce--------	40 15 35 40 40 15	Tamarack, white cedar, black spruce.
565---------------- Eckvoll	2o	Slight	Slight	Slight	Slight	Quaking aspen------- Bur oak------------- American basswood---	70 45 60	Red pine, northern red oak, white spruce.
1842F*:								
Cushing-----------	2r	Moderate	Moderate	Moderate	Slight	Sugar maple--------- Eastern white pine-- Red maple----------- American basswood--- Northern red oak----	60 --- --- --- 64	Eastern white pine, red pine, white spruce.
Flak--------------	2d	Moderate	Moderate	Slight	Moderate	Northern red oak---- Red pine------------ Quaking aspen------- Eastern white pine-- American basswood--- Jack pine-----------	64 55 75 55 60 55	Red pine, white spruce, eastern white pine.
1843C*:								
Cushing-----------	2o	Slight	Slight	Slight	Slight	Sugar maple--------- Eastern white pine-- Red maple----------- American basswood--- Northern red oak----	60 --- --- --- 64	Eastern white pine, red pine, white spruce.
DeMontreville-----	3s	Slight	Slight	Moderate	Slight	Red pine------------ Eastern white pine-- Jack pine----------- White spruce--------	56 54 60 57	Red pine, white spruce, jack pine.

See footnote at end of table.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
1843E*:								
Cushing-----------	2r	Moderate	Moderate	Moderate	Slight	Sugar maple--------- Eastern white pine-- Red maple----------- American basswood--- Northern red oak----	60 --- --- --- 64	Eastern white pine, red pine, white spruce.
DeMontreville-----	3s	Moderate	Moderate	Moderate	Slight	Red pine------------ Eastern white pine-- Jack pine----------- White spruce--------	56 54 60 57	Red pine, white spruce, jack pine.
1902B-------------- Jewett	2o	Slight	Slight	Slight	Slight	Sugar maple--------- Northern red oak---- American basswood---	60 --- ---	Eastern white pine, red pine.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
5A, 5B Dakota	Tatarian honeysuckle, Siberian peashrub, lilac.	Eastern redcedar, hackberry, Manchurian crabapple.	Eastern white pine, honeylocust, jack pine, green ash, Russian-olive, bur oak.	---	---
7A, 7B, 7C Hubbard	---	Eastern redcedar, Siberian peashrub, Tatarian honeysuckle, lilac.	Red pine, jack pine.	Eastern white pine	---
25 Becker	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Eastern white pine, Austrian pine, hackberry, green ash.	Silver maple.
32B, 32C, 32E, 32F Nebish	---	Amur maple, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, white spruce, eastern redcedar, Manchurian crabapple, blue spruce.	Eastern white pine, green ash, red pine.	---
35 Blue Earth	---	Northern white-cedar, lilac, Tatarian honeysuckle, Siberian peashrub.	Hackberry, bur oak, white spruce, eastern redcedar.	Green ash, golden willow, green ash.	Eastern cottonwood.
36 Flom	---	Common chokecherry, Tatarian honeysuckle, Siberian peashrub, eastern redcedar, lilac.	Russian-olive, white spruce, bur oak, blue spruce.	Golden willow, Siberian elm.	Eastern cottonwood.
38B, 38C, 38D Waukon	---	Siberian peashrub, redosier dogwood, lilac, Amur maple.	Northern white-cedar, eastern redcedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, eastern white pine.	---
41A, 41B, 41C Estherville	Lilac, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, Manchurian crabapple.	Honeylocust, jack pine, eastern white pine, green ash, bur oak, Russian-olive.	---	---
69B Fedji	Lilac	Eastern redcedar, Tatarian honeysuckle, Russian-olive, Siberian peashrub.	Eastern white pine, Norway spruce, red pine, hackberry, honeylocust, green ash, Amur maple.	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
72----------------- Shooker	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
75----------------- Bluffton	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
109---------------- Cordova	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, hackberry, tall purple willow, Amur maple.	Green ash, golden willow.	Eastern cottonwood, silver maple.
114---------------- Glencoe	---	American plum, redosier dogwood, Tatarian honeysuckle.	Hackberry, Amur maple, tall purple willow, white spruce, northern white-cedar.	Green ash, golden willow.	Eastern cottonwood, silver maple.
119B--------------- Pomroy	---	American cranberrybush, Siberian peashrub, Amur maple, lilac.	Eastern redcedar, red pine, blue spruce, white spruce.	Norway spruce, jack pine, green ash, eastern white pine.	---
125---------------- Beltrami	---	Redosier dogwood, lilac, American cranberrybush, Siberian peashrub.	White spruce, blue spruce, eastern redcedar.	Norway spruce, eastern white pine, green ash, red pine, jack pine.	---
129---------------- Cylinder	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, northern white-cedar, Amur maple, white spruce.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
133B--------------- Dalbo	---	Northern white-cedar, Amur maple, lilac, American cranberrybush, Siberian peashrub, Tatarian honeysuckle.	White spruce, Manchurian crabapple, eastern redcedar.	Green ash, jack pine, eastern white pine.	---
142---------------- Nokay	---	Siberian peashrub, American cranberrybush, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Norway spruce, jack pine, red pine, eastern white pine, green ash.	---
144B, 144C, 144E-- Flak	---	Tatarian honeysuckle, Amur maple, American cranberrybush, northern white-cedar, Siberian peashrub, lilac.	Manchurian crabapple, eastern redcedar, white spruce.	Eastern white pine, jack pine, green ash.	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
155B--------------- Chetek	Lilac, Siberian peashrub, silver buffaloberry.	Eastern redcedar, Manchurian crabapple, Siberian crabapple, Tatarian honeysuckle.	Eastern white pine, red pine, jack pine, green ash, Russian-olive.	---	---
156A, 156B-------- Fairhaven	Lilac, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, Manchurian crabapple, hackberry.	Russian-olive, bur oak, green ash, eastern white pine, jack pine, honeylocust.	---	---
159B--------------- Anoka	---	American cranberrybush, Siberian peashrub, lilac, Amur maple.	Eastern redcedar, blue spruce, red pine, white spruce.	Eastern white pine, Norway spruce, jack pine, green ash.	---
163B--------------- Brainerd	---	Northern white-cedar, American cranberrybush, Amur maple, Tatarian honeysuckle, Siberian peashrub, lilac.	Eastern redcedar, Manchurian crabapple, white spruce.	Eastern white pine, green ash, jack pine.	---
179B--------------- Langola	---	American cranberrybush, lilac, Siberian peashrub, Amur maple.	Eastern redcedar, blue spruce, red pine, white spruce.	Eastern white pine, Norway spruce, jack pine, green ash.	---
180A, 180B-------- Gonvick	---	Siberian peashrub, American cranberrybush, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Norway spruce, jack pine, red pine, eastern white pine, green ash.	---
181---------------- Litchfield	---	Redosier dogwood, lilac, Tatarian honeysuckle.	White spruce, blue spruce, Amur maple, northern white-cedar.	Austrian pine, hackberry, green ash, eastern white pine.	Silver maple.
183---------------- Dassel	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, northern white-cedar, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
200B, 200C-------- Holdingford	---	Amur maple, American cranberrybush, lilac, Siberian peashrub.	White spruce, red pine, blue spruce, eastern redcedar.	Norway spruce, eastern white pine, green ash, jack pine.	---
204B, 204C, 204E-- Cushing	---	Redosier dogwood, Siberian peashrub, lilac, Amur maple.	Northern white-cedar, eastern redcedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, eastern white pine.	---
207B, 207C, 207E-- Nymore	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub.	Jack pine, red pine.	Eastern white pine	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
218 Watab	---	Siberian peashrub, American cranberrybush, lilac, redosier dogwood.	Eastern redcedar, blue spruce, white spruce.	Norway spruce, red pine, jack pine, eastern white pine, green ash.	---
233B Growton	---	Redosier dogwood, Siberian peashrub, lilac, American cranberrybush.	White spruce, blue spruce, eastern redcedar.	Norway spruce, red pine, eastern white pine, green ash, jack pine.	---
236 Vallers	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, hackberry, Siberian crabapple, Black Hills spruce, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
255 Mayer	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
260 Duelm	---	Siberian peashrub, American cranberrybush, lilac, redosier dogwood.	White spruce, blue spruce.	Norway spruce, green ash, jack pine, eastern white pine, red pine, jack pine.	---
261 Isan	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
281 Darfur	---	Redosier dogwood, Tatarian honeysuckle, American plum.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
292B Alstad	---	Siberian peashrub, American cranberrybush, redosier dogwood, lilac.	Eastern redcedar, white spruce, blue spruce.	Norway spruce, jack pine, red pine, eastern white pine, green ash.	---
318 Mayer	---	Tatarian honeysuckle, lilac, Siberian peashrub, northern white-cedar.	Bur oak, hackberry, white spruce, eastern redcedar.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
325 Prebish	Lilac, common ninebark.	Siberian peashrub, redosier dogwood, American cranberrybush.	Northern white-cedar, white spruce, blue spruce.	Norway spruce, eastern white pine, green ash.	Silver maple.
327A, 327B Dickman	Siberian peashrub, Tatarian honeysuckle, lilac.	Eastern redcedar, hackberry, Manchurian crabapple.	Green ash, honeylocust, eastern white pine, jack pine, Russian-olive, bur oak.	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
392, 399: Biscay	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
406B, 406C, 406E: Dorset	Silver buffaloberry, Siberian peashrub, Tatarian honeysuckle, lilac.	Eastern redcedar, Siberian crabapple, Manchurian crabapple.	Jack pine, Russian-olive, eastern white pine, red pine, green ash.	---	---
413: Osakis	---	Eastern redcedar, Peking cotoneaster, common chokecherry, redosier dogwood, Tatarian honeysuckle, Siberian peashrub, American plum.	Manchurian crabapple, white spruce, blue spruce.	Golden willow	Eastern cottonwood.
414: Hamel	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, hackberry, white spruce, Amur maple, tall purple willow.	Golden willow, green ash.	Eastern cottonwood, silver maple.
421B, 421C: Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
446A, 446B: Normania	---	Lilac, redosier dogwood, Tatarian honeysuckle.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Eastern white pine, Austrian pine, hackberry, green ash.	Silver maple.
453B, 453C: DeMontreville	---	American cranberrybush, Siberian peashrub, lilac, Amur maple.	Eastern redcedar, red pine, blue spruce, white spruce.	Eastern white pine, Norway spruce, jack pine, green ash.	---
454B, 454C, 454E, 454F: Mahtomedi	---	Eastern redcedar, Tatarian honeysuckle, lilac, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
459: Corunna	---	White spruce, silky dogwood, American cranberrybush, Tatarian honeysuckle.	Northern white-cedar, Manchurian crabapple.	Green ash, eastern white pine, Norway spruce, golden willow.	Carolina poplar.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
461B, 461C: Koronis	---	Redosier dogwood, lilac, gray dogwood, Siberian peashrub.	Blue spruce, eastern redcedar, northern white-cedar, Amur maple, hackberry, Russian-olive.	Eastern white pine, green ash.	---
465: Kalmarville	---	Tatarian honeysuckle, American plum, redosier dogwood.	Tall purple willow, hackberry, northern white-cedar, white spruce, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
511: Marcellon	---	Lilac, Tatarian honeysuckle, redosier dogwood.	White spruce, blue spruce, northern white-cedar, Amur maple.	Eastern white pine, Austrian pine, hackberry, green ash.	Silver maple.
525: Muskego	Common ninebark	Tatarian honeysuckle.	---	Golden willow, white willow.	Carolina poplar.
540: Seelyeville	Common ninebark	Tatarian honeysuckle.	---	Golden willow, white willow.	Carolina poplar.
541: Rifle	Common ninebark	Tatarian honeysuckle.	---	Golden willow, white willow.	Carolina poplar.
543: Markey	Common ninebark	Tatarian honeysuckle.	---	Golden willow, white willow.	Carolina poplar.
544: Cathro	Common ninebark	Tatarian honeysuckle.	---	Golden willow, white willow.	Carolina poplar.
565: Eckvoll	---	Lilac, redosier dogwood, American cranberrybush, Siberian peashrub.	Blue spruce, white spruce, northern white-cedar, eastern redcedar.	Eastern white pine, jack pine, red pine, green ash.	---
566: Regal	---	Siberian peashrub, lilac, Tatarian honeysuckle, northern white-cedar.	Eastern redcedar, bur oak, white spruce, hackberry.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
571: Coriff	---	Siberian peashrub, lilac, Tatarian honeysuckle, northern white-cedar.	Eastern redcedar, bur oak, white spruce, hackberry.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
572: Lowlein	---	Lilac, redosier dogwood, Tatarian honeysuckle.	White spruce, northern white-cedar, blue spruce, Amur maple.	Eastern white pine, Austrian pine, hackberry, green ash.	Silver maple.
582: Roliss	---	Siberian peashrub, lilac, northern white-cedar.	Eastern redcedar, Manchurian crabapple, blue spruce, Russian-olive, white spruce, bur oak.	Green ash, golden willow.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
591B: Doland	---	Tatarian honeysuckle, redosier dogwood, lilac, eastern redcedar, Siberian peashrub, American plum.	Blue spruce, bur oak, green ash, Manchurian crabapple, ponderosa pine, Russian-olive.	---	---
597: Tara	---	Tatarian honeysuckle, common chokecherry, Peking cotoneaster, eastern redcedar, Siberian peashrub, American plum, redosier dogwood.	White spruce, blue spruce, Manchurian crabapple.	Golden willow	Eastern cottonwood.
611C, 611D: Hawick	Lilac, Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar	Jack pine, Austrian pine, red pine.	Eastern white pine	---
639A, 639B: Ridgeport	Tatarian honeysuckle, lilac, Siberian peashrub.	Eastern redcedar, hackberry, Manchurian crabapple.	Eastern white pine, jack pine, honeylocust, Russian-olive, bur oak, green ash.	---	---
804D*:					
Koronis	---	Redosier dogwood, lilac, gray dogwood, Siberian peashrub.	Blue spruce, eastern redcedar, northern white-cedar, Amur maple, hackberry, Russian-olive.	Eastern white pine, green ash.	---
Estherville	Lilac, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, Manchurian crabapple.	Honeylocust, jack pine, eastern white pine, green ash, bur oak, Russian-olive.	---	---
807D*:					
Koronis	---	Redosier dogwood, lilac, gray dogwood, Siberian peashrub.	Blue spruce, eastern redcedar, northern white-cedar, Amur maple, hackberry, Russian-olive.	Eastern white pine, green ash.	---
Sunburg	American plum	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
848*: Urban land.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
848*:					
Osakis	---	Eastern redcedar, Peking cotoneaster, common chokecherry, redosier dogwood, Tatarian honeysuckle, Siberian peashrub, American plum.	Manchurian crabapple, white spruce, blue spruce.	Golden willow	Eastern cottonwood.
850*:					
Urban land.					
Dassel	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, northern white-cedar, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
865B*:					
Urban land.					
Hubbard	---	Eastern redcedar, Siberian peashrub, Tatarian honeysuckle, lilac.	Red pine, jack pine.	Eastern white pine	---
873*:					
Prebish	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
Nokay	---	Siberian peashrub, American cranberrybush, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Norway spruce, jack pine, red pine, eastern white pine, green ash.	---
875B*:					
Estherville	Lilac, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, Manchurian crabapple.	Honeylocust, jack pine, eastern white pine, green ash, bur oak, Russian-olive.	---	---
Hawick	Lilac, Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar	Jack pine, Austrian pine, red pine.	Eastern white pine	---
954C*, 954D*:					
Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
954C*, 954D*:					
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
999B*, 999C*, 999D*:					
Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
Estherville	Lilac, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, Manchurian crabapple.	Honeylocust, jack pine, eastern white pine, green ash, bur oak, Russian-olive.	---	---
1013*. Pits					
1015. Psamments					
1016. Udorthents					
1018. Udifluvents					
1029*. Pits					
1055*: Histosols.					
Aquolls.					
1064*: Rock outcrop.					
Lithic Eutrochrepts.					
1805 Blue Earth Variant	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, white spruce, eastern redcedar.	Green ash, golden willow, green ash.	Eastern cottonwood.
1825C. Seelyeville					
1828 Glencoe	---	American plum, redosier dogwood, Tatarian honeysuckle.	Hackberry, Amur maple, tall purple willow, white spruce, northern white-cedar.	Green ash, golden willow.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1842F*:					
Cushing	---	Redosier dogwood, Siberian peashrub, lilac, Amur maple.	Northern white-cedar, eastern redcedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, eastern white pine.	---
Flak	---	Tatarian honeysuckle, Amur cranberrybush, northern white-cedar, Siberian peashrub, lilac.	Manchurian crabapple, white spruce.	Eastern white pine, jack pine,	---
1843C*, 1843E*:					
Cushing	---	Redosier dogwood, Siberian peashrub, lilac, Amur maple.	Northern white-cedar, eastern redcedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, eastern white pine.	---
DeMontreville	---	American cranberrybush, Siberian peashrub, lilac, Amur maple.	Eastern redcedar, red pine, blue spruce, white spruce.	Eastern white pine, Norway spruce, jack pine, green ash.	---
1879 Seelyeville	Common ninebark	Tatarian honeysuckle.	---	Golden willow, white willow.	Carolina poplar.
1880. Martisco					
1892 Prebish	---	Siberian peashrub, common ninebark, lilac, American cranberrybush, redosier dogwood.	Northern white-cedar, white spruce, Norway spruce, blue spruce.	Eastern white pine, green ash.	Silver maple.
1902B Jewett	---	Common ninebark, northern white-cedar, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
5A Dakota	Slight	Slight	Moderate: small stones.	Slight	Slight.
5B Dakota	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
7A Hubbard	Slight	Slight	Slight	Slight	Severe: droughty.
7B Hubbard	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
7C Hubbard	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
25 Becker	Severe: flooding.	Slight	Slight	Slight	Slight.
32B Nebish	Slight	Slight	Moderate: slope.	Slight	Slight.
32C Nebish	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
32E Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
32F Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35 Blue Earth	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
36 Flom	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
38B Waukon	Slight	Slight	Moderate: slope.	Slight	Slight.
38C Waukon	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
38D Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
41A Estherville	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
41B Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
41C Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
69B Fedji	Slight	Slight	Moderate: slope.	Slight	Slight.
72 Shooker	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
75------------------- Bluffton	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
109------------------ Cordova	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
114------------------ Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
119B----------------- Pomroy	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty.
125------------------ Beltrami	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
129------------------ Cylinder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight------------	Slight.
133B----------------- Dalbo	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
142------------------ Nokay	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
144B----------------- Flak	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight------------	Moderate: droughty.
144C----------------- Flak	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight------------	Moderate: droughty, slope.
144E----------------- Flak	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
155B----------------- Chetek	Slight----------	Slight----------	Moderate: slope, small stones.	Slight------------	Moderate: large stones, droughty.
156A----------------- Fairhaven	Slight----------	Slight----------	Slight----------	Slight------------	Slight.
156B----------------- Fairhaven	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
159B----------------- Anoka	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
163B----------------- Brainerd	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones.	Moderate: wetness.	Moderate: wetness, droughty.
179B----------------- Langola	Slight----------	Slight----------	Moderate: slope.	Slight------------	Moderate: droughty.
180A----------------- Gonvick	Slight----------	Slight----------	Slight----------	Slight------------	Slight.
180B----------------- Gonvick	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
181------------------ Litchfield	Slight----------	Slight----------	Moderate: slope.	Slight------------	Moderate: droughty.
183------------------ Dassel	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
200B----------------- Holdingford	Slight----------	Slight----------	Severe: slope.	Slight------------	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
200C: Holdingford	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
204B: Cushing	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
204C: Cushing	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
204E: Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
207B: Nymore	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones.	Slight	Severe: droughty.
207C: Nymore	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope.	Slight	Severe: droughty.
207E: Nymore	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope, droughty.
218: Watab	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness, droughty.
233B: Growton	Slight	Slight	Moderate: slope.	Slight	Slight.
236: Vallers	Severe: wetness, excess humus.	Severe: excess humus.	Severe: large stones, excess humus, wetness.	Severe: excess humus.	Moderate: large stones, wetness.
255: Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
260: Duelm	Moderate: wetness.	Moderate: wetness.	Moderate: small stones, wetness.	Slight	Moderate: droughty.
261: Isan	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
281: Darfur	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
292B: Alstad	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
318: Mayer	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
325: Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
327A: Dickman	Slight	Slight	Slight	Slight	Moderate: droughty.
327B: Dickman	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
392: Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
399------------------- Biscay	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
406B------------------ Dorset	Slight----------	Slight----------	Moderate: slope, small stones.	Slight------------	Moderate: droughty.
406C------------------ Dorset	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight------------	Moderate: droughty, slope.
406E------------------ Dorset	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
413------------------- Osakis	Slight----------	Slight----------	Slight----------	Slight------------	Moderate: droughty.
414------------------- Hamel	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
421B------------------ Ves	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
421C------------------ Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight------------	Moderate: slope.
446A, 446B------------ Normania	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
453B------------------ DeMontreville	Slight----------	Slight----------	Moderate: slope, small stones.	Slight------------	Slight.
453C------------------ DeMontreville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight------------	Moderate: slope.
454B------------------ Mahtomedi	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Moderate: too sandy.	Moderate: droughty.
454C------------------ Mahtomedi	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Moderate: too sandy.	Moderate: droughty, slope.
454E, 454F------------ Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: too sandy.	Severe: slope.
459------------------- Corunna	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
461B------------------ Koronis	Slight----------	Slight----------	Moderate: slope, small stones.	Slight------------	Slight.
461C------------------ Koronis	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight------------	Moderate: slope.
465------------------- Kalmarville	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
511------------------- Marcellon	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
525------------------- Muskego	Severe: excess humus, ponding.	Severe: excess humus, ponding.	Severe: excess humus, ponding.	Severe: excess humus, ponding.	Severe: excess humus, ponding.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
540: Seelyeville	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
541: Rifle	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
543: Markey	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
544: Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
565: Eckvoll	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Slight	Slight.
566: Regal	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, droughty.
571: Coriff	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
572: Lowlein	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
582: Roliss	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
591B: Doland	Slight	Slight	Moderate: slope.	Slight	Slight.
597: Tara	Slight	Slight	Moderate: slope.	Slight	Slight.
611C: Hawick	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
611D: Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
639A: Ridgeport	Slight	Slight	Slight	Slight	Slight.
639B: Ridgeport	Slight	Slight	Moderate: slope.	Slight	Slight.
804D*:					
Koronis	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Estherville	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
807D*:					
Koronis	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
848*:					
Urban land.					
Osakis	Slight	Slight	Slight	Slight	Moderate: droughty.
850*:					
Urban land.					
Dassel	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
865B*:					
Urban land.					
Hubbard	Slight	Slight	Severe: slope.	Slight	Severe: droughty.
873*:					
Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Nokay	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
875B*:					
Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
Hawick	Slight	Slight	Moderate: slope, small stones.	Slight	Severe: droughty.
954C*:					
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
954D*:					
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
999B*:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
999C*:					
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
999D*:					
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
999D*:					
Estherville	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
1013*. Pits					
1015. Psamments					
1016. Udorthents					
1018. Udifluvents					
1029*. Pits					
1055*: Histosols.					
Aquolls.					
1064*: Rock outcrop.					
Lithic Eutrochrepts.					
1805 Blue Earth Variant	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
1825C Seelyeville	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness.	Severe: wetness, excess humus.	Severe: wetness, excess humus.
1828 Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1842F*:					
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Flak	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1843C*:					
Cushing	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
DeMontreville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
1843E*:					
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
DeMontreville	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
1879 Seelyeville	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1880------------------- Martisco	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
1892------------------- Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1902B------------------ Jewett	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
5A, 5B Dakota	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
7A, 7B, 7C Hubbard	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
25 Becker	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
32B, 32C Nebish	Fair	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
32E Nebish	Poor	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
32F. Nebish										
35 Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
36 Flom	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
38B Waukon	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
38C Waukon	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
38D Waukon	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
41A, 41B, 41C Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
69B Fedji	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
72 Shooker	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
75 Bluffton	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
109 Cordova	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
114 Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
119B Pomroy	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
125 Beltrami	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
129 Cylinder	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
133B Dalbo	Fair	Good	Good	Good	Poor	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
142----------------- Nokay	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
144B, 144C---------- Flak	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
144E---------------- Flak	Poor	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
155B---------------- Chetek	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
156A, 156B---------- Fairhaven	Good	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
159B---------------- Anoka	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
163B---------------- Brainerd	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
179B---------------- Langola	Poor	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
180A---------------- Gonvick	Good	Good	Good	Good	Fair	Poor	Poor	Good	Good	Poor.
180B---------------- Gonvick	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
181----------------- Litchfield	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
183----------------- Dassel	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair.
200B, 200C---------- Holdingford	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
204B---------------- Cushing	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
204C---------------- Cushing	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
204E---------------- Cushing	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
207B, 207C---------- Nymore	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
207E---------------- Nymore	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
218----------------- Watab	Fair	Fair	Good	Good	Fair	Fair	Fair	Fair	Good	Fair.
233B---------------- Growton	Good	Good	Good	Good	Good	Poor	Poor	Good	Fair	Poor.
236----------------- Vallers	Good	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair	Fair.
255----------------- Mayer	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
260----------------- Duelm	Poor	Poor	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
261----------------- Isan	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
281----------------- Darfur	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
292B---------------- Alstad	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
318----------------- Mayer	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
325----------------- Prebish	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
327A, 327B---------- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
392----------------- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
399----------------- Biscay	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
406B---------------- Dorset	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
406C---------------- Dorset	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
406E---------------- Dorset	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
413----------------- Osakis	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Poor	Poor.
414----------------- Hamel	Good	Good	Fair	Good	Fair	Good	Good	Good	Fair	Good.
421B---------------- Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
421C---------------- Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
446A, 446B---------- Normania	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
453B---------------- DeMontreville	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
453C---------------- DeMontreville	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
454B, 454C---------- Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
454E, 454F. Mahtomedi										
459----------------- Corunna	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
461B---------------- Koronis	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
461C---------------- Koronis	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
465----------------- Kalmarville	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
511----------------- Marcellon	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
525----------------- Muskego	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
540----------------- Seelyeville	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
541----------------- Rifle	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
543----------------- Markey	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Fair.
544----------------- Cathro	Poor	Fair	Fair	Fair	Fair	Good	Good	Poor	Poor	Good.
565----------------- Eckvoll	Poor	Fair	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
566----------------- Regal	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
571----------------- Coriff	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
572----------------- Lowlein	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
582----------------- Roliss	Good	Good	Fair	Fair	Fair	Very poor.	Poor	Good	Fair	Very poor.
591B---------------- Doland	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
597----------------- Tara	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
611C---------------- Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
611D---------------- Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
639A, 639B---------- Ridgeport	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
804D*:										
Koronis------------	Poor	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Estherville--------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
807D*:										
Koronis------------	Poor	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Sunburg------------	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
848*: Urban land.										
Osakis	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Poor	Poor.
850*: Urban land.										
Dassel	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair.
865B*: Urban land.										
Hubbard	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
873*: Prebish	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
Nokay	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
875B*: Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
954C*: Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
954D*: Ves	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
999B*: Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
999C*: Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
999D*: Ves	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Estherville	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
1013*. Pits										

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1015. Psamments										
1016. Udorthents										
1018. Udifluvents										
1029*. Pits										
1055*: Histosols.										
Aquolls.										
1064*: Rock outcrop.										
Lithic Eutrochrepts.										
1805---------------- Blue Earth Variant	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
1825C--------------- Seelyeville	Poor	Poor	Poor	Poor	Poor	Good	Fair	Poor	Poor	Fair.
1828---------------- Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
1842F*: Cushing.										
Flak.										
1843C*: Cushing------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
DeMontreville------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
1843E*: Cushing------------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
DeMontreville------	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
1879---------------- Seelyeville	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
1880---------------- Martisco	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
1892---------------- Prebish	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
1902B--------------- Jewett	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
5A----------------- Dakota	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: low strength, frost action.	Slight.
5B----------------- Dakota	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength, frost action.	Slight.
7A----------------- Hubbard	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
7B----------------- Hubbard	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Severe: droughty.
7C----------------- Hubbard	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
25----------------- Becker	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding, frost action.	Slight.
32B---------------- Nebish	Slight---------	Moderate: shrink-swell.	Slight---------	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell.	Slight.
32C---------------- Nebish	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, shrink-swell.	Moderate: slope.
32E, 32F----------- Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35----------------- Blue Earth	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding.	Severe: flooding, ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
36----------------- Flom	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Severe: wetness.
38B---------------- Waukon	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell.	Slight.
38C---------------- Waukon	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, frost action, shrink-swell.	Moderate: slope.
38D---------------- Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
41A---------------- Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
41B---------------- Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
41C---------------- Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
69B---------------- Fedji	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength.	Slight.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
72-----------------Shooker	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
75-----------------Bluffton	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
109----------------Cordova	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
114----------------Glencoe	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
119B---------------Pomroy	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
125----------------Beltrami	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Slight.
129----------------Cylinder	Severe: cutbanks cave, wetness.	Moderate: shrink-swell, wetness.	Severe: wetness.	Moderate: shrink-swell, wetness.	Severe: frost action.	Slight.
133B---------------Dalbo	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
142----------------Nokay	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
144B---------------Flak	Moderate: dense layer.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: droughty.
144C---------------Flak	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
144E---------------Flak	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
155B---------------Chetek	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: large stones, droughty.
156A---------------Fairhaven	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
156B---------------Fairhaven	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
159B---------------Anoka	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
163B---------------Brainerd	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
179B---------------Langola	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
180A, 180B---------Gonvick	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: frost action.	Slight.
181----------------Litchfield	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Moderate: droughty.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
183 Dassel	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
200B Holdingford	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
200C Holdingford	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
204B Cushing	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
204C Cushing	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
204E Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
207B Nymore	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
207C Nymore	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
207E Nymore	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, droughty.
218 Watab	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
233B Growton	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
236 Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: large stones, wetness.
255 Mayer	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
260 Duelm	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: droughty.
261 Isan	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
281 Darfur	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
292B Alstad	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
318 Mayer	Severe: cutbanks cave, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: frost action, ponding.	Severe: ponding.
325 Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
327A Dickman	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
327B------------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
392-------------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
399-------------- Biscay	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
406B------------- Dorset	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
406C------------- Dorset	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
406E------------- Dorset	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
413-------------- Osakis	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Moderate: droughty.
414-------------- Hamel	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
421B------------- Ves	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength, frost action.	Slight.
421C------------- Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
446A, 446B-------- Normania	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
453B------------- DeMontreville	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
453C------------- DeMontreville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
454B------------- Mahtomedi	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
454C------------- Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
454E, 454F-------- Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
459-------------- Corunna	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
461B------------- Koronis	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action, low strength.	Slight.
461C------------- Koronis	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, low strength.	Moderate: slope.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
465. Kalmarville	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.	Severe: wetness, flooding.
511. Marcellon	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, frost action.	Moderate: wetness, flooding.
525. Muskego	Severe: excess humus, ponding.	Severe: low strength, ponding.	Severe: low strength, ponding.	Severe: low strength, ponding.	Severe: frost action, low strength, ponding.	Severe: excess humus, ponding.
540. Seelyeville	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
541. Rifle	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
543. Markey	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
544. Cathro	Severe: excess humus, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding, excess humus.
565. Eckvoll	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
566. Regal	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
571. Coriff	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
572. Lowlein	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Slight.
582. Roliss	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
591B. Doland	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
597. Tara	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
611C. Hawick	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
611D. Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
639A. Ridgeport	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
639B. Ridgeport	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
804D*:						
Koronis----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Estherville------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
807D*:						
Koronis----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sunburg----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
848*:						
Urban land.						
Osakis-----------	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Moderate: droughty.
850*:						
Urban land.						
Dassel-----------	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
865B*:						
Urban land.						
Hubbard----------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Severe: droughty.
873*:						
Prebish----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
Nokay------------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
875B*:						
Estherville------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
Hawick-----------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Severe: droughty.
954C*:						
Ves--------------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Storden----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
954D*:						
Ves--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
999B*:						
Ves--------------	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength, frost action.	Slight.

* See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
999B*:						
Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
999C*:						
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
999D*:						
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Estherville	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1013*. Pits						
1015. Psamments						
1016. Udorthents						
1018. Udifluvents						
1029*. Pits						
1055*: Histosols.						
Aquolls.						
1064*: Rock outcrop.						
Lithic Eutrochrepts.						
1805 Blue Earth Variant	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
1825C Seelyeville	Severe: excess humus, wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, frost action.	Severe: wetness, excess humus.
1828 Glencoe	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
1842F*:						
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Flak	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1843C*:						
Cushing----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
DeMontreville----	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
1843E*:						
Cushing----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
DeMontreville----	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1879-------------- Seelyeville	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding, excess humus.
1880-------------- Martisco	Severe: ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: ponding, flooding, excess humus.
1892-------------- Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: frost action, ponding.	Severe: ponding.
1902B------------- Jewett	Moderate: dense layer.	Moderate: shrink-swell.	Slight---------	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
5A, 5B-------------- Dakota	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
7A, 7B-------------- Hubbard	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
7C------------------ Hubbard	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
25------------------ Becker	Severe: poor filter.	Severe: seepage.	Severe: seepage, wetness, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
32B----------------- Nebish	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
32C----------------- Nebish	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
32E, 32F------------ Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
35------------------ Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
36------------------ Flom	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
38B----------------- Waukon	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
38C----------------- Waukon	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
38D----------------- Waukon	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
41A, 41B------------ Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
41C----------------- Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
69B----------------- Fedji	Moderate: percs slowly.	Severe: seepage.	Slight-----------	Severe: seepage.	Good.
72------------------ Shooker	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
75------------------ Bluffton	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
109----------------- Cordova	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
114----------------- Glencoe	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
119B---------------- Pomroy	Severe: percs slowly.	Severe: seepage.	Slight-----------	Severe: seepage.	Fair: small stones.
125----------------- Beltrami	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
129----------------- Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
133B---------------- Dalbo	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
142----------------- Nokay	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
144B---------------- Flak	Severe: percs slowly.	Severe: seepage.	Slight-----------	Severe: seepage.	Fair: small stones.
144C---------------- Flak	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.
144E---------------- Flak	Severe: percs slowly, slope.	Severe: seepage, slope.	Severe: slope.	Severe: seepage, slope.	Poor: slope.
155B---------------- Chetek	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
156A, 156B---------- Fairhaven	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, small stones, too sandy.
159B---------------- Anoka	Slight-----------	Severe: seepage.	Severe: seepage, too sandy.	Slight-----------	Fair: too sandy, thin layer.
163B---------------- Brainerd	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage.	Fair: small stones, wetness.
179B---------------- Langola	Severe: percs slowly.	Severe: seepage.	Slight-----------	Severe: seepage.	Fair: small stones.
180A, 180B---------- Gonvick	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
181: Litchfield	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
183: Dassel	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
200B: Holdingford	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
200C: Holdingford	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
204B: Cushing	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
204C: Cushing	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
204E: Cushing	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
207B: Nymore	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
207C: Nymore	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
207E: Nymore	Severe: slope, poor filter.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
218: Watab	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage.	Fair: small stones, wetness.
233B: Growton	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: wetness.
236: Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
255: Mayer	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
260: Duelm	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
261: Isan	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
281----------------- Darfur	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
292B---------------- Alstad	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
318----------------- Mayer	Severe: ponding, poor filter.	Severe: ponding, seepage.	Severe: seepage, ponding, too sandy.	Severe: ponding, seepage.	Poor: ponding, too sandy, seepage.
325----------------- Prebish	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
327A, 327B---------- Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
392----------------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
399----------------- Biscay	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, small stones.
406B---------------- Dorset	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
406C---------------- Dorset	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
406E---------------- Dorset	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
413----------------- Osakis	Severe: poor filter, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
414----------------- Hamel	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
421B---------------- Ves	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
421C---------------- Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
446A, 446B---------- Normania	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
453B---------------- DeMontreville	Severe: percs slowly.	Severe: seepage.	Slight-----------	Severe: seepage.	Fair: small stones.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
453C: DeMontreville	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.
454B: Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454C: Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454E, 454F: Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
459: Corunna	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
461B: Koronis	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
461C: Koronis	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
465: Kalmarville	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness, seepage.	Poor: wetness.
511: Marcellon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: wetness.
525: Muskego	Severe: percs slowly, ponding.	Severe: seepage, excess humus, ponding.	Severe: excess humus, ponding.	Severe: seepage, ponding.	Poor: hard to pack, ponding.
540: Seelyeville	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding, excess humus.
541: Rifle	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
543: Markey	Severe: ponding, percs slowly, poor filter.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
544: Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
565: Eckvoll	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
566 Regal	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, too sandy.	Severe: wetness, seepage.	Poor: seepage, too sandy, small stones.
571 Coriff	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
572 Lowlein	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: wetness.
582 Roliss	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
591B Doland	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
597 Tara	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Slight	Fair: wetness.
611C Hawick	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
611D Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
639A, 639B Ridgeport	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
804D*:					
Koronis	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Estherville	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
807D*:					
Koronis	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Sunburg	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
848*:					
Urban land.					
Osakis	Severe: poor filter, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
850*:					
Urban land.					

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
850*:					
Dassel	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
865B*: Urban land.					
Hubbard	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
873*:					
Prebish	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
Nokay	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
875B*:					
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Hawick	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
954C*:					
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
954D*:					
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
999B*:					
Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
999C*:					
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
999D*:					
Ves----------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Estherville---------	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
1013*. Pits					
1015. Psamments					
1016. Udorthents					
1018. Udifluvents					
1029*. Pits					
1055*: Histosols.					
Aquolls.					
1064*: Rock outcrop.					
Lithic Eutrochrepts.					
1805---------------- Blue Earth Variant	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, small stones.
1825C--------------- Seelyeville	Severe: wetness, percs slowly.	Severe: seepage, excess humus.	Severe: wetness, excess humus.	Severe: seepage, wetness.	Poor: wetness, excess humus.
1828---------------- Glencoe	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
1842F*:					
Cushing------------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Flak---------------	Severe: percs slowly, slope.	Severe: seepage, slope.	Severe: slope.	Severe: seepage, slope.	Poor: slope.
1843C*:					
Cushing------------	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
DeMontreville------	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1843E*:					
Cushing	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
DeMontreville	Severe: percs slowly, slope.	Severe: seepage, slope.	Severe: slope.	Severe: seepage, slope.	Poor: slope.
1879 Seelyeville	Severe: flooding, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
1880 Martisco	Severe: flooding, ponding, percs slowly.	Severe: seepage, flooding, excess humus.	Severe: flooding, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
1892 Prebish	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1902B Jewett	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: large stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
5A, 5B Dakota	Good	Probable	Probable	Poor: small stones, area reclaim.
7A, 7B, 7C Hubbard	Good	Probable	Improbable: too sandy.	Poor: too sandy.
25 Becker	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim, thin layer.
32B Nebish	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
32C Nebish	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
32E Nebish	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
32F Nebish	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
35 Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
36 Flom	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
38B Waukon	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
38C Waukon	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
38D Waukon	Fair: slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
41A, 41B, 41C Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
69B Fedji	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy, small stones.
72 Shooker	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
75 Bluffton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
109 Cordova	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
114 Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
119B: Pomroy	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
125: Beltrami	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
129: Cylinder	Fair: wetness.	Probable	Improbable: too sandy.	Fair: area reclaim, small stones, thin layer.
133B: Dalbo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
142: Nokay	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
144B, 144C: Flak	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
144E: Flak	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
155B: Chetek	Good	Probable	Probable	Poor: small stones, area reclaim.
156A, 156B: Fairhaven	Good	Probable	Probable	Poor: area reclaim, small stones.
159B: Anoka	Good	Probable	Improbable: too sandy.	Fair: too sandy.
163B: Brainerd	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
179B: Langola	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, too sandy, small stones.
180A, 180B: Gonvick	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
181: Litchfield	Fair: wetness.	Probable	Improbable: too sandy.	Fair: too sandy, thin layer.
183: Dassel	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
200B, 200C: Holdingford	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
204B, 204C: Cushing	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
204E: Cushing	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
207B, 207C: Nymore	Good	Probable	Improbable: too sandy.	Poor: too sandy.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
207E-------- Nymore	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
218-------- Watab	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
233B-------- Growton	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
236-------- Vallers	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
255-------- Mayer	Fair: wetness.	Probable	Probable	Fair: area reclaim, thin layer.
260-------- Duelm	Fair: wetness.	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
261-------- Isan	Poor: wetness.	Probable	Improbable: too sandy.	Poor: thin layer, wetness.
281-------- Darfur	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
292B-------- Alstad	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
318-------- Mayer	Poor: wetness.	Probable	Probable	Poor: wetness.
325-------- Prebish	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
327A, 327B-------- Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
392-------- Biscay	Fair: wetness.	Probable	Probable	Poor: area reclaim.
399-------- Biscay	Poor: wetness.	Probable	Probable	Poor: area reclaim, wetness.
406B, 406C-------- Dorset	Good	Probable	Probable	Poor: small stones, area reclaim.
406E-------- Dorset	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
413-------- Osakis	Good	Probable	Probable	Poor: small stones, area reclaim.
414-------- Hamel	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
421B-------- Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
421C-------- Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
446A, 446B: Normania	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
453B, 453C: DeMontreville	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
454B, 454C: Mahtomedi	Good	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
454E: Mahtomedi	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
454F: Mahtomedi	Poor: slope.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
459: Corunna	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, wetness.
461B: Koronis	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
461C: Koronis	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
465: Kalmarville	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
511: Marcellon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
525: Muskego	Poor: wetness.	Improbable: excess humus.	Improbable: excess humus.	Poor: wetness, excess humus.
540: Seelyeville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
541: Rifle	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
543: Markey	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
544: Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
565: Eckvoll	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
566: Regal	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
571: Coriff	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, thin layer.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
572----------------- Lowlein	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, thin layer.
582----------------- Roliss	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
591B---------------- Doland	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
597----------------- Tara	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
611C---------------- Hawick	Good----------------	Probable------------	Probable------------	Poor: small stones, area reclaim.
611D---------------- Hawick	Poor: slope.	Probable------------	Probable------------	Poor: small stones, area reclaim, slope.
639A, 639B---------- Ridgeport	Good----------------	Probable------------	Improbable: too sandy.	Fair: small stones, area reclaim, thin layer.
804D*:				
Koronis-------------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Estherville---------	Fair: slope.	Probable------------	Probable------------	Poor: small stones, area reclaim, slope.
807D*:				
Koronis-------------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Sunburg-------------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
848*: Urban land.				
Osakis--------------	Good----------------	Probable------------	Probable------------	Poor: small stones, area reclaim.
850*: Urban land.				
Dassel--------------	Poor: wetness.	Probable------------	Improbable: too sandy.	Poor: wetness.
865B*: Urban land.				
Hubbard-------------	Good----------------	Probable------------	Improbable: too sandy.	Poor: too sandy.
873*:				
Prebish-------------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
873*:				
Nokay	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
875B*:				
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
954C*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
954D*:				
Ves	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
999B*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
999C*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
999D*:				
Ves	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Estherville	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
1013*. Pits				
1015. Psamments				
1016. Udorthents				
1018. Udifluvents				
1029*. Pits				

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1055*:				
Histosols.				
Aquolls.				
1064*:				
Rock outcrop.				
Lithic Eutrochrepts.				
1805------------------ Blue Earth Variant	Poor: wetness.	Probable-------------	Probable-------------	Poor: area reclaim, wetness.
1825C----------------- Seelyeville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
1828------------------ Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1842F*:				
Cushing--------------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Flak-----------------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
1843C*:				
Cushing--------------	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
DeMontreville--------	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
1843E*:				
Cushing--------------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
DeMontreville--------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
1879------------------ Seelyeville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
1880------------------ Martisco	Poor: ponding, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
1892------------------ Prebish	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1902B----------------- Jewett	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
5A-----------------Dakota	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable------	Too sandy------	Favorable.
5B-----------------Dakota	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope----------	Too sandy------	Favorable.
7A, 7B-------------Hubbard	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
7C-----------------Hubbard	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
25-----------------Becker	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing---	Soil blowing, too sandy.	Favorable.
32B----------------Nebish	Moderate: seepage, slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Soil blowing---	Favorable.
32C, 32E, 32F------Nebish	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
35-----------------Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
36-----------------Flom	Slight---------	Severe: ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
38B----------------Waukon	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Favorable------	Favorable.
38C, 38D-----------Waukon	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope----------	Slope.
41A----------------Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
41B----------------Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
41C----------------Estherville	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
69B----------------Fedji	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, fast intake, slope.	Soil blowing---	Favorable.
72-----------------Shooker	Moderate: seepage.	Severe: wetness, piping.	Frost action---	Wetness--------	Wetness--------	Wetness.
75-----------------Bluffton	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
109----------------Cordova	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
114 Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding	Ponding	Wetness.
119B Pomroy	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Rooting depth, soil blowing.	Droughty, rooting depth.
125 Beltrami	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
129 Cylinder	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Favorable.
133B Dalbo	Moderate: seepage, slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
142 Nokay	Severe: seepage.	Severe: piping.	Frost action	Wetness, soil blowing, rooting depth.	Wetness, rooting depth, soil blowing.	Wetness, rooting depth.
144B Flak	Moderate: slope.	Severe: piping.	Deep to water	Droughty, soil blowing, rooting depth.	Rooting depth, soil blowing.	Droughty, rooting depth.
144C, 144E Flak	Severe: slope.	Severe: piping.	Deep to water	Droughty, soil blowing, rooting depth.	Slope, rooting depth, soil blowing.	Slope, droughty, rooting depth.
155B Chetek	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
156A Fairhaven	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable	Erodes easily, too sandy.	Erodes easily.
156B Fairhaven	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope	Erodes easily, too sandy.	Erodes easily.
159B Anoka	Moderate: seepage, slope.	Severe: piping.	Deep to water	Fast intake, soil blowing, slope.	Soil blowing	Favorable.
163B Brainerd	Severe: seepage.	Severe: piping.	Favorable	Wetness, droughty, soil blowing.	Wetness, rooting depth.	Droughty, rooting depth.
179B Langola	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Soil blowing	Droughty.
180A, 180B Gonvick	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
181 Litchfield	Severe: seepage.	Severe: piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
183 Dassel	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
200B Holdingford	Moderate: seepage, slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Rooting depth, soil blowing.	Rooting depth.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
200C: Holdingford	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Slope, rooting depth, soil blowing.	Slope, rooting depth.
204B: Cushing	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
204C, 204E: Cushing	Severe: slope.	Moderate: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
207B: Nymore	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, fast intake.	Soil blowing, too sandy.	Droughty.
207C, 207E: Nymore	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
218: Watab	Severe: seepage.	Severe: piping.	Favorable	Wetness, droughty, fast intake.	Wetness, rooting depth, soil blowing.	Droughty, rooting depth.
233B: Growton	Moderate: seepage.	Severe: piping.	Deep to water	Soil blowing, rooting depth.	Soil blowing	Rooting depth.
236: Vallers	Slight	Severe: piping, wetness.	Frost action	Wetness	Wetness	Wetness.
255: Mayer	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
260: Duelm	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
261: Isan	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Ponding, too sandy, soil blowing.	Wetness, droughty.
281: Darfur	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
292B: Alstad	Moderate: seepage.	Moderate: piping, wetness.	Frost action	Wetness, soil blowing.	Wetness, soil blowing.	Wetness.
318: Mayer	Severe: seepage.	Severe: seepage, ponding.	Frost action, ponding, cutbanks cave.	Ponding	Ponding, too sandy.	Wetness.
325: Prebish	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
327A: Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
327B: Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
392: Biscay	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
399----- Biscay	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding-----	Ponding, too sandy.	Wetness.
406B----- Dorset	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
406C, 406E----- Dorset	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
413----- Osakis	Severe: seepage.	Severe: seepage.	Deep to water	Droughty-----	Too sandy-----	Droughty.
414----- Hamel	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness-----	Wetness-----	Wetness.
421B----- Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope-----	Erodes easily	Erodes easily.
421C----- Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
446A----- Normania	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Favorable-----	Erodes easily	Erodes easily.
446B----- Normania	Moderate: seepage, slope.	Moderate: piping, wetness.	Deep to water	Slope-----	Erodes easily	Erodes easily.
453B----- DeMontreville	Severe: seepage.	Moderate: seepage, piping.	Deep to water	Fast intake, soil blowing.	Soil blowing---	Rooting depth.
453C----- DeMontreville	Severe: seepage, slope.	Moderate: seepage, piping.	Deep to water	Fast intake, soil blowing.	Slope, soil blowing.	Slope, rooting depth.
454B----- Mahtomedi	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
454C, 454E, 454F-- Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.
459----- Corunna	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding, soil blowing.	Erodes easily, ponding, too sandy.	Wetness, erodes easily.
461B----- Koronis	Severe: seepage.	Severe: piping.	Deep to water	Slope-----	Favorable-----	Favorable.
461C----- Koronis	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope-----	Slope-----	Slope.
465----- Kalmarville	Severe: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, soil blowing, flooding.	Wetness, soil blowing.	Wetness.
511----- Marcellon	Severe: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness-----	Wetness-----	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
525 Muskego	Severe: seepage.	Severe: excess humus, ponding.	Percs slowly, subsides, ponding.	Ponding, soil blowing, percs slowly.	Ponding, soil blowing, percs slowly.	Wetness, percs slowly.
540 Seelyeville	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
541 Rifle	Severe: seepage.	Severe: excess humus, ponding.	Ponding, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
543 Markey	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
544 Cathro	Severe: seepage.	Severe: piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
565 Eckvoll	Severe: seepage.	Moderate: piping, wetness.	Frost action	Wetness, fast intake, soil blowing.	Wetness, soil blowing.	Rooting depth.
566 Regal	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy.	Wetness, droughty.
571 Coriff	Severe: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
572 Lowlein	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing	Erodes easily, soil blowing.	Erodes easily.
582 Roliss	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Wetness	Wetness.
591B Doland	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
597 Tara	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
611C, 611D Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
639A Ridgeport	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, rooting depth.	Soil blowing	Rooting depth.
639B Ridgeport	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Soil blowing	Rooting depth.
804D*:						
Koronis	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope	Slope	Slope.
Estherville	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
807D*:						
Koronis	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope	Slope	Slope.
Sunburg	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope	Slope	Slope.
848*: Urban land.						
Osakis	Severe: seepage.	Severe: seepage.	Deep to water	Droughty	Too sandy	Droughty.
850*: Urban land.						
Dassel	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
865B*: Urban land.						
Hubbard	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
873*:						
Prebish	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
Nokay	Severe: seepage.	Severe: piping.	Frost action	Wetness, soil blowing, rooting depth.	Wetness, rooting depth, soil blowing.	Wetness, rooting depth.
875B*:						
Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
Hawick	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
954C*, 954D*:						
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
999B*:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
999C*, 999D*:						
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
999C*, 999D*:						
Estherville	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
1013*. Pits						
1015. Psamments						
1016. Udorthents						
1018. Udifluvents						
1029*. Pits						
1055*: Histosols.						
Aquolls.						
1064*: Rock outcrop.						
Lithic Eutrochrepts.						
1805 Blue Earth Variant	Severe: seepage.	Severe: seepage, ponding.	Ponding, frost action, cutbanks cave.	Ponding	Ponding, too sandy.	Wetness.
1825C Seelyeville	Severe: seepage.	Severe: excess humus, wetness.	Subsides, frost action, slope.	Wetness, soil blowing, slope.	Wetness, soil blowing.	Wetness.
1828 Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding	Ponding	Wetness.
1842F*:						
Cushing	Severe: slope.	Moderate: piping.	Deep to water	Slope, soil blowing.	Slope, soil blowing.	Slope.
Flak	Severe: slope.	Severe: piping.	Deep to water	Droughty, soil blowing, rooting depth.	Slope, rooting depth, soil blowing.	Slope, droughty, rooting depth.
1843C*, 1843E*:						
Cushing	Severe: slope.	Moderate: piping.	Deep to water	Slope, soil blowing.	Slope, soil blowing.	Slope.
DeMontreville	Severe: seepage, slope.	Moderate: seepage, piping.	Deep to water	Fast intake, soil blowing.	Slope, soil blowing.	Slope, rooting depth.
1879 Seelyeville	Severe: seepage.	Severe: excess humus, ponding.	Ponding, flooding, subsides.	Ponding, soil blowing, flooding.	Ponding, soil blowing.	Wetness.
1880 Martisco	Severe: seepage.	Severe: ponding.	Percs slowly, flooding, frost action.	Ponding, percs slowly, flooding.	Ponding, percs slowly.	Wetness, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
1892-------------- Prebish	Moderate: seepage.	Severe: piping, ponding.	Frost action, ponding.	Ponding--------	Ponding--------	Wetness.
1902B------------- Jewett	Moderate: seepage, slope.	Severe: piping.	Deep to water	Rooting depth, slope.	Favorable------	Rooting depth.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
5A, 5B----------- Dakota	0-27	Loam, silt loam	CL, ML	A-4, A-6	0	95-100	85-100	75-95	50-85	25-35	7-15
	27-45	Loamy sand, coarse sand, sandy loam.	SM, SP-SM, GM, GP-GM	A-2, A-4, A-1	0-5	55-100	45-100	40-90	10-40	<21	NP-4
	45-60	Sand, gravelly coarse sand, loamy sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	50-100	45-100	30-90	2-5	---	NP
7A, 7B, 7C------- Hubbard	0-14	Loamy sand-------	SM, SP-SM	A-2	0	98-100	95-100	50-80	10-25	<20	NP
	14-48	Sand, coarse sand, loamy sand.	SP-SM, SW-SM	A-1, A-3, A-2-4	0	98-100	70-100	25-75	5-12	<20	NP
	48-60	Sand, coarse sand	SP, SW	A-1, A-3	0	95-100	70-100	20-70	2-5	<20	NP
25--------------- Becker	0-16	Fine sandy loam	ML, SM	A-4	0	100	95-100	75-95	40-55	<25	NP-4
	16-33	Sandy loam, fine sandy loam, loam.	ML, SM	A-4	0	100	85-100	75-95	35-70	<25	NP-4
	33-47	Loamy coarse sand, loamy fine sand, gravelly loamy coarse sand.	SM	A-2, A-1	0	95-100	65-100	35-75	15-35	<20	NP
	47-60	Loamy coarse sand, loamy fine sand, fine sand.	SM, SP-SM	A-1, A-2, A-3	0	95-100	65-100	35-70	5-15	<20	NP
32B, 32C, 32E, 32F------------- Nebish	0-9	Sandy loam-------	SM	A-4	0-3	95-100	90-100	75-85	35-50	20-35	NP-7
	9-31	Clay loam, sandy clay loam, loam.	SC, CL, ML, SM	A-4, A-6, A-7	0-3	95-100	90-100	70-95	40-75	20-50	5-20
	31-60	Loam, sandy loam, fine sandy loam.	SC, CL, ML, SM	A-4, A-6	0-3	95-100	90-100	70-95	35-70	20-40	3-20
35--------------- Blue Earth	0-6	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	6-38	Mucky silty clay loam, clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
	38-60	Clay loam, loam, silt loam.	CL, ML	A-6, A-7	0	95-100	90-100	80-100	70-95	35-50	11-20
36--------------- Flom	0-9	Loam-------------	OL, CL-ML, CL	A-4, A-6, A-7	0	95-100	95-100	80-100	60-90	20-50	5-20
	9-24	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-50	10-30
	24-60	Loam, clay loam	CL	A-6, A-7	0	95-100	90-98	80-95	60-90	20-50	10-30
38B, 38C, 38D---- Waukon	0-7	Loam-------------	OL, ML, CL, CL-ML	A-6, A-7, A-4	0	95-100	90-98	80-95	60-90	20-50	3-30
	7-14	Clay loam, loam, sandy clay loam.	CL, SC	A-6, A-7	0	95-100	90-98	70-95	40-75	20-50	10-30
	14-60	Sandy loam, loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	95-100	90-98	60-90	35-80	15-40	3-20
41A, 41B, 41C---- Estherville	0-15	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	15-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
69B-------------- Fedji	0-12	Loamy sand, loamy fine sand.	SM	A-2	0	100	95-100	50-75	15-30	---	NP
	12-27	Fine sand, sand, loamy sand.	SM, SP-SM	A-2	0	100	95-100	50-75	10-30	---	NP
	27-40	Loam, silt loam, clay loam.	CL	A-6	0	95-100	90-100	80-95	60-75	20-40	10-20
	40-60	Loam, silt loam, clay loam.	CL, CL-ML	A-6, A-4	0	95-100	90-100	80-95	60-75	20-40	5-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
72---------------- Shooker	0-15	Loam-------------	ML, CL-ML, CL	A-4, A-6	0-3	95-100	90-98	80-95	50-75	20-40	4-14
	15-36	Loam, clay loam, sandy clay loam.	ML, CL, CL-ML	A-6, A-4	0-3	95-100	90-98	70-95	50-70	20-40	3-20
	36-60	Loam, fine sandy loam, sandy loam.	ML, CL, SC, SM	A-4, A-6	0-3	95-100	90-98	70-95	40-65	20-40	2-20
75---------------- Bluffton	0-19	Loam-------------	CL	A-6, A-7	0	98-100	85-100	85-95	50-80	30-45	10-20
	19-33	Fine sandy loam, loam, sandy clay loam, clay loam.	SM, ML, CL, SC	A-4, A-6	0-3	95-100	85-100	70-90	40-60	20-35	3-18
	33-60	Loam, sandy clay loam, fine sandy loam.	CL, ML, SC, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-65	20-40	3-20
109--------------- Cordova	0-13	Loam-------------	OL, ML, MH, OH	A-6, A-7	0	95-100	95-100	90-100	70-85	38-60	12-25
	13-30	Silty clay loam, clay loam.	CL	A-7	0	90-100	90-100	85-95	65-90	40-50	20-30
	30-60	Clay loam, loam	CL	A-6	0-5	90-100	90-100	80-95	55-70	30-40	12-20
114--------------- Glencoe	0-16	Loam-------------	OL, OH, MH, ML	A-7	0	100	95-100	85-98	75-90	45-60	10-20
	16-55	Loam, clay loam, silty clay loam.	CL	A-7, A-6	0	100	95-100	85-98	75-90	35-50	15-25
	55-60	Loam, clay loam	CL	A-6, A-7	0	98-100	90-98	80-98	70-85	35-50	15-25
119B-------------- Pomroy	0-9	Fine sand--------	SM, SP-SM	A-2, A-1-B	0	100	95-100	45-70	10-25	---	NP
	9-25	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2, A-1-B	0	100	95-100	45-80	10-35	---	NP
	25-29	Gravelly loamy fine sand, loamy fine sand, loamy sand.	SM, GM	A-2, A-1-B	0-10	55-95	50-90	35-55	15-35	---	NP
	29-60	Sandy loam, fine sandy loam.	SM, SM-SC, GM, GM-GC	A-4, A-2	0-5	70-95	65-90	50-85	30-50	14-20	1-5
125--------------- Beltrami	0-15	Loam-------------	ML, CL, CL-ML	A-4	0-3	95-100	85-95	75-90	50-65	20-30	3-10
	15-35	Loam, clay loam, sandy clay loam.	CL	A-6, A-7	0-3	95-100	85-98	75-90	50-70	25-45	10-20
	35-60	Loam, sandy loam, fine sandy loam.	CL-ML, CL, SC, SM-SC	A-4, A-6	1-3	95-100	85-95	70-95	35-65	20-40	5-20
129--------------- Cylinder	0-14	Loam-------------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	10-25
	14-26	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	10-20
	26-60	Loamy coarse sand, gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0-10	75-95	75-95	20-55	5-25	---	NP
133B-------------- Dalbo	0-14	Loam, very fine sandy loam.	CL, ML, SM, CL-ML	A-4	0	100	95-100	75-90	35-60	<25	2-10
	14-30	Loam, silty clay, clay loam.	CL, CH	A-7, A-4	0	100	95-100	95-100	85-100	40-65	20-40
	30-60	Silty clay loam, silty clay, clay.	CL, CH	A-6, A-7	0	100	95-100	95-100	85-100	30-60	10-35
142--------------- Nokay	0-12	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-2	90-100	80-100	55-85	25-50	<25	NP-4
	12-24	Sandy loam, fine sandy loam, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	20-30	2-7
	24-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
144B, 144C, 144E- Flak	0-3	Sandy loam--------	SM	A-2, A-4	0-2	90-100	80-100	60-80	25-45	<22	NP-4
	3-19	Loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
	19-42	Sandy loam--------	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
	42-60	Sandy loam--------	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
155B-------------- Chetek	0-13	Sandy loam--------	SM, SM-SC	A-2, A-4	0-15	80-100	75-100	45-70	25-40	<23	2-6
	13-23	Loam, sandy loam, gravelly sandy loam.	ML, CL, SM, SC	A-2, A-4, A-6, A-1	0-15	80-100	70-100	45-95	20-75	21-31	3-13
	23-60	Stratified sand to gravel.	SP, SP-SM	A-1	0-15	55-95	50-80	15-50	1-5	---	NP
156A, 156B-------- Fairhaven	0-15	Loam--------------	ML, CL	A-4, A-6	0	95-100	95-100	80-95	60-85	25-40	NP-15
	15-30	Silt loam, loam, silty clay loam.	ML, CL	A-4, A-6	0	95-100	95-100	80-95	60-85	25-40	2-15
	30-60	Stratified gravelly loamy coarse sand to sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	50-100	35-100	20-50	1-10	---	NP
159B-------------- Anoka	0-14	Loamy sand--------	SM	A-2	0	100	100	95-100	20-35	<20	NP
	14-36	Fine sandy loam, very fine sandy loam, loamy sand.	SM	A-2, A-4	0	100	95-100	90-100	30-50	<20	NP-4
	36-75	Fine sandy loam, fine sand, sand.	SM, SP-SM	A-2	0	100	95-100	90-100	12-35	---	NP
163B-------------- Brainerd	0-15	Fine sandy loam	SM	A-2, A-4	0-2	90-100	80-100	60-85	25-45	<22	NP-4
	15-22	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-4	85-95	75-93	50-70	25-40	<22	NP-4
	22-55	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-2	85-95	75-95	50-70	25-40	<22	NP-4
	55-60	Sandy loam--------	SM	A-2, A-4	0-2	85-95	75-95	50-70	25-40	<22	NP-4
179B-------------- Langola	0-19	Loamy sand--------	SM	A-2	0	100	100	55-85	15-30	---	NP
	19-38	Loamy fine sand, loamy sand, fine sand.	SM, SP-SM	A-2, A-3	5-20	85-95	85-95	55-80	5-30	---	NP
	38-60	Fine sandy loam, sandy loam.	SM	A-2, A-4	5-15	85-95	75-95	55-75	20-40	<20	NP-4
180A, 180B-------- Gonvick	0-12	Loam--------------	ML, CL, CL-ML	A-4, A-6	0-3	95-100	90-98	85-95	50-75	20-40	3-20
	12-25	Loam, clay loam, sandy clay loam.	CL-ML, CL, SC, SM-SC	A-4, A-6, A-7	0-3	95-100	90-98	70-90	40-70	15-45	5-25
	25-60	Loam, sandy loam, clay loam.	CL-ML, CL, SC, SM-SC	A-4, A-6	0-3	95-100	90-98	70-95	35-70	20-40	5-20
181--------------- Litchfield	0-19	Loamy sand--------	SM	A-2	0	100	100	80-95	15-35	<20	NP-4
	19-43	Stratified fine sand to very fine sandy loam.	SM	A-2	0	100	100	80-95	20-35	<20	NP-4
	43-60	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	70-95	5-30	<20	NP-4
183--------------- Dassel	0-11	Sandy loam--------	SM	A-4	0	100	95-100	70-85	40-50	<30	NP-4
	11-28	Stratified loamy fine sand to fine sandy loam.	SM	A-4, A-2	0	100	95-100	60-75	30-40	<30	NP-4
	28-60	Stratified loamy sand to gravelly coarse sand.	SM, SP-SM	A-2	0	100	80-100	50-80	10-35	---	NP
200B, 200C-------- Holdingford	0-12	Sandy loam--------	SM	A-2	0-2	95-100	85-97	60-70	25-35	12-20	NP-4
	12-37	Fine sandy loam, sandy loam, loam.	SM, SC, ML, CL	A-4	5-10	90-98	75-95	60-90	35-70	15-30	2-10
	37-60	Sandy loam, fine sandy loam, loam.	SM, ML, CL-ML, SM-SC	A-4	3-7	90-98	75-95	60-90	35-70	<20	NP-5

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
204B, 204C, 204E-- Cushing	0-12	Sandy loam--------	SM, SM-SC, ML, CL-ML	A-4, A-2, A-1	0-7	75-100	75-100	45-95	20-65	<25	2-7
	12-19	Loam, silt loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-7	75-100	75-100	35-100	12-90	<23	NP-6
	19-31	Loam, sandy clay loam, sandy loam.	SC, CL	A-2, A-4, A-6	0-7	75-100	75-100	45-95	20-75	25-40	9-21
	31-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-2, A-4, A-6, A-1	0-7	75-100	75-100	45-95	20-75	<34	2-20
207B, 207C, 207E-- Nymore	0-9	Loamy sand--------	SM, SP-SM	A-2, A-3	0	95-100	80-100	50-75	5-30	<20	NP
	9-60	Sand, coarse sand	SP, SP-SM, SM	A-1, A-3, A-2	0	95-100	80-100	45-75	2-15	<20	NP
218-------------- Watab	0-14	Loamy fine sand	SM	A-2	0	100	95-100	75-90	15-35	<20	NP
	14-20	Loamy fine sand, fine sandy loam, fine sand.	SM, SP-SM	A-2, A-3, A-1	0	95-100	95-100	10-90	5-35	<20	NP
	20-24	Gravelly fine sandy loam, sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0-10	80-95	70-90	50-85	25-50	<20	1-5
	24-60	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0-5	80-95	70-90	50-85	25-50	<20	1-5
233B------------- Growton	0-11	Sandy loam--------	SM, SM-SC	A-4, A-2	0-5	95-100	90-100	75-95	15-45	<20	NP-5
	11-37	Fine sandy loam, sandy loam, loam.	CL, SC, SM-SC, CL-ML	A-4	0-5	95-100	90-100	50-80	40-80	<30	4-10
	37-60	Sandy loam, loam	SM, SM-SC	A-4, A-2	0-5	80-95	80-95	60-80	10-45	<25	4-7
236-------------- Vallers	0-8	Loam--------------	OL, CL, ML	A-6, A-7	3-20	95-100	95-100	95-100	85-95	30-50	11-20
	8-15	Clay loam, silty clay loam, sandy clay loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
255-------------- Mayer	0-24	Loam--------------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	24-40	Loam, sandy clay loam, silt loam.	CL, SC, ML, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-85	30-40	5-15
	40-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
260-------------- Duelm	0-19	Loamy sand--------	SM, SP-SM	A-2, A-1	0	90-100	85-100	35-80	10-25	<20	NP
	19-30	Loamy sand, loamy coarse sand, sand.	SM, SP-SM	A-2, A-3, A-1	0	90-100	80-100	35-80	5-25	<20	NP
	30-60	Coarse sand-------	SP, SM, SP-SM	A-2, A-3, A-1	0	90-100	80-100	35-85	3-15	<20	NP
261-------------- Isan	0-20	Loamy sand--------	SM	A-2	0	95-100	92-100	50-75	12-30	<20	NP
	20-60	Sand, coarse sand	SM, SP	A-1, A-2, A-3	0	85-100	80-100	35-70	2-15	<20	NP
281-------------- Darfur	0-17	Sandy loam, coarse sandy loam.	SM	A-4	0	100	100	70-100	35-50	20-30	NP-5
	17-30	Sandy loam, loam, loamy sand.	SM	A-4	0	100	100	70-100	35-50	20-30	NP-5
	30-60	Stratified fine sand to fine sandy loam.	SM	A-2, A-4	0	100	100	50-100	15-40	---	---
292B------------- Alstad	0-13	Sandy loam--------	ML, SM, CL-ML, SM-SC	A-4, A-2	0	95-100	95-100	55-85	25-55	<25	2-7
	13-35	Sandy clay loam, clay loam, loam.	CL, SC	A-6, A-4, A-2	0	80-100	75-100	60-100	25-80	20-40	9-28
	35-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-6, A-4, A-2	0-3	80-100	75-100	45-95	20-75	<35	2-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
318---------------- Mayer	0-22	Loam----------------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	22-29	Loam, sandy clay loam, silt loam.	CL, SC, ML, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-85	30-40	5-15
	29-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
325---------------- Prebish	0-18	Sandy loam--------	SM	A-4	0-2	90-100	90-100	55-80	35-50	<20	NP-4
	18-42	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	80-95	77-90	45-80	25-50	<20	NP-4
	42-60	Sandy loam, fine sandy loam, loam.	SM	A-2	0-10	80-95	77-85	55-70	20-35	<20	NP-4
327A, 327B--------- Dickman	0-19	Sandy loam--------	SM, SM-SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	19-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
392---------------- Biscay	0-16	Loam----------------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	16-26	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	26-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
399---------------- Biscay	0-16	Loam----------------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	16-41	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	41-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
406B, 406C, 406E- Dorset	0-10	Sandy loam--------	SM, SM-SC	A-4, A-2	0	90-100	85-100	50-70	25-50	<25	NP-5
	10-19	Loam, sandy loam	SM-SC, SC, CL-ML, CL	A-4, A-6	0	90-100	85-100	50-90	35-75	15-30	4-14
	19-23	Loamy sand, gravelly loamy coarse sand, gravelly sand.	SP-SM, SM, SM-SC	A-1, A-2	0-5	50-90	35-80	20-50	10-25	<20	NP-7
	23-60	Gravelly coarse sand, gravelly sand, coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	40-90	35-80	15-40	0-10	<20	NP
413---------------- Osakis	0-9	Loam----------------	ML, CL, CL-ML	A-4	0	95-100	85-100	80-95	50-75	20-35	2-10
	9-19	Loam, sandy loam	SM, ML, CL-ML, SM-SC	A-4	0	95-100	85-100	55-90	36-70	20-35	1-10
	19-60	Coarse sand, loamy coarse sand, gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0	30-95	20-80	10-50	0-10	<20	NP
414---------------- Hamel	0-12	Loam----------------	ML, CL	A-6, A-4	0	100	97-100	85-98	60-85	25-40	8-16
	12-36	Clay loam, loam, silty clay loam.	CH, CL	A-7	0	98-100	95-100	85-95	65-80	40-55	25-35
	36-60	Loam, clay loam	CL	A-6, A-7	0-5	98-100	95-100	80-95	60-80	30-45	10-25
421B, 421C--------- Ves	0-12	Loam----------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	12-26	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	26-60	Loam----------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
446A, 446B--------- Normania	0-14	Loam----------------	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
	14-26	Loam, clay loam	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-85	25-40	8-20
	26-60	Loam----------------	CL	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
453B, 453C------- DeMontreville	0-28	Loamy sand, coarse sand.	SM	A-2	0-5	90-100	85-100	65-80	20-35	<20	NP
	28-45	Sandy loam, sandy clay loam, loam.	SC, SM, CL, ML	A-2, A-4	0-5	80-100	70-90	55-70	20-55	15-25	3-10
	45-60	Sandy loam, coarse sandy loam.	SC, SM, SM-SC	A-2, A-4	0-5	80-100	70-90	45-65	25-45	15-25	3-8
454B, 454C, 454E, 454F------------ Mahtomedi	0-5	Loamy coarse sand, coarse sand.	SM, SM-SC	A-2, A-1	0-1	95-100	60-90	40-70	15-30	<20	NP-4
	5-25	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-70	5-15	<20	NP
	25-60	Sand, coarse sand, gravelly coarse sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-5	75-95	50-90	30-70	2-15	<20	NP
459-------------- Corunna	0-8	Loam-------------	SM, ML, SC, CL	A-2, A-4	0-5	95-100	95-100	65-85	25-70	<30	NP-10
	8-32	Sandy loam, loamy sand.	SM, SC, SM-SC	A-4, A-2	0-5	95-100	95-100	50-75	15-40	<30	NP-10
	32-60	Silty clay loam, clay loam, loam.	CL	A-6, A-7	0	100	95-100	90-100	70-90	25-50	11-25
461B, 461C------- Koronis	0-8	Loam-------------	CL-ML, CL	A-4, A-6	0-5	85-100	80-95	75-90	50-70	25-35	5-14
	8-27	Sandy clay loam, loam, fine sandy loam.	SC, CL	A-6, A-7	0-5	85-100	80-95	70-90	35-70	30-45	10-20
	27-60	Sandy loam, fine sandy loam, loam.	SM-SC, CL-ML, SC, CL	A-4, A-2	0-5	85-100	80-95	50-85	25-60	20-30	5-10
465-------------- Kalmarville	0-42	Sandy loam, loam	SM	A-4	0	95-100	90-100	60-85	35-50	<25	NP-4
	42-60	Coarse sand, sand, loamy fine sand.	SP, SM, SW, SP-SM	A-3, A-2, A-1	0-2	90-100	85-100	40-80	2-30	<25	NP
511-------------- Marcellon	0-15	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	0-1	85-100	75-100	65-100	45-90	20-30	6-11
	15-32	Loam, clay loam, sandy clay loam.	CL, SC	A-6, A-2	0-1	85-100	75-95	60-95	25-80	30-35	11-14
	32-60	Sandy loam, fine sandy loam, gravelly sandy loam.	SM, SM-SC	A-2, A-4	3-5	75-90	65-90	45-80	25-50	<23	1-6
525-------------- Muskego	0-31	Muck-------------	PT	A-8	0	---	---	---	---	---	---
	31-60	Coprogenous earth	OH, OL	A-8	0	---	---	---	---	---	---
540-------------- Seelyeville	0-10	Muck-------------	PT	A-8	0	---	---	---	---	---	---
	10-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
541-------------- Rifle	0-8	Mucky peat-------	PT	A-8	0	---	---	---	---	---	---
	8-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
543-------------- Markey	0-25	Muck-------------	PT	A-8	---	---	---	---	---	---	---
	25-60	Sand, sandy loam, gravelly coarse sand.	SP, SM, SP-SM	A-2, A-3	0	100	85-100	60-75	0-20	---	NP
544-------------- Cathro	0-14	Muck-------------	PT	A-8	0	---	---	---	---	---	---
	14-40	Sapric material	PT	A-8	0	---	---	---	---	---	---
	40-60	Sandy loam, loam, silt loam.	SM, ML, SC, CL	A-4	0-5	80-100	65-100	60-100	35-90	<25	3-10
565-------------- Eckvoll	0-9	Loamy sand-------	SM, SM-SC	A-4, A-2	0-2	90-100	85-100	45-80	25-50	<20	NP-7
	9-22	Fine sand, sand, loamy sand.	SM, SP-SM	A-1, A-2, A-3	0-2	90-100	85-100	45-75	5-30	<20	NP-4
	22-40	Clay loam, sandy clay loam, loam.	SC, CL	A-4, A-6, A-7	0-5	90-100	85-97	65-95	45-75	25-50	7-25
	40-60	Loam, clay loam	CL	A-4, A-6, A-7	0-5	90-100	85-97	70-95	55-80	25-45	7-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
566---------------Regal	0-15	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-100	65-85	50-75	25-40	5-20
	15-18	Loam, sandy clay loam, sandy loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0	95-100	85-100	60-85	35-70	20-35	5-15
	18-60	Loamy coarse sand, gravelly coarse sand, sand.	SP, SM, SP-SM	A-1, A-2, A-3	0-5	70-95	45-85	10-75	2-30	<20	NP
571---------------Coriff	0-18	Loam-------------	ML, CL, CL-ML	A-4	0	90-100	85-100	80-90	50-80	20-30	2-10
	18-24	Sandy loam, fine sandy loam.	SM-SC, SM	A-4	0	90-100	85-100	60-80	35-50	<20	NP-5
	24-34	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	90-100	85-100	50-75	5-35	---	NP
	34-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	90-100	85-100	80-90	50-80	25-40	5-15
572---------------Lowlein	0-13	Sandy loam--------	SM, SM-SC	A-4	0	90-100	85-100	60-75	35-50	<20	NP-5
	13-21	Sandy loam, fine sandy loam.	SM, SM-SC	A-4	0	90-100	85-100	60-80	35-50	<20	NP-5
	21-30	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	90-100	85-100	50-75	5-35	---	NP
	30-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	90-100	85-100	80-90	55-80	25-40	5-15
582---------------Roliss	0-14	Loam-------------	CL, CL-ML	A-4, A-6, A-7	0	95-100	80-100	80-100	60-90	20-50	5-30
	14-22	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	80-100	80-90	60-80	20-50	10-30
	22-60	Loam, clay loam	CL, CL-ML	A-6, A-7, A-4	0	95-100	80-98	80-95	60-80	20-50	5-30
591B--------------Doland	0-9	Silt loam---------	OL, ML	A-4, A-6	0	100	100	90-100	70-90	30-40	2-12
	9-24	Silt loam---------	ML, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	2-12
	24-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0	90-100	85-98	80-90	55-80	20-40	6-20
597---------------Tara	0-23	Silt loam---------	OL, ML	A-4, A-6	0	100	100	90-100	70-90	30-40	2-12
	23-35	Silt loam, loam	ML, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	2-12
	35-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-2	95-100	85-95	80-90	55-80	20-40	6-20
611C, 611D-------Hawick	0-10	Loamy sand--------	SM, SP-SM	A-1, A-2	0-5	85-100	80-95	40-70	10-25	---	NP
	10-19	Loamy coarse sand, gravelly coarse sand, coarse sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	19-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
639A, 639B-------Ridgeport	0-13	Sandy loam--------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	70-90	25-50	15-30	2-10
	13-34	Sandy loam, gravelly sandy loam.	SM, SC, SM-SC	A-2, A-4	0	95-100	85-100	65-85	20-45	15-30	2-10
	34-60	Gravelly loamy sand, gravelly sand, sand.	SW, SP, SW-SM, SP-SM	A-1	0-5	80-95	75-95	35-50	2-10	<25	NP-6
804D*:											
Koronis----------	0-8	Loam-------------	CL-ML, CL	A-4, A-6	0-5	85-100	80-95	75-90	50-70	25-35	5-14
	8-27	Sandy clay loam, loam, fine sandy loam.	SC, CL	A-6, A-7	0-5	85-100	80-95	70-90	35-70	30-45	10-20
	27-60	Sandy loam, fine sandy loam, loam.	SM-SC, CL-ML, SC, CL	A-4, A-2	0-5	85-100	80-95	50-85	25-60	20-30	5-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
804D*:											
Estherville	0-15	Sandy loam	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	15-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
807D*:											
Koronis	0-8	Loam	CL-ML, CL	A-4, A-6	0-5	85-100	80-95	75-90	50-70	25-35	5-14
	8-27	Sandy clay loam, loam, fine sandy loam.	SC, CL	A-6, A-7	0-5	85-100	80-95	70-90	35-70	30-45	10-20
	27-60	Sandy loam, fine sandy loam, loam.	SM-SC, CL-ML, SC, CL	A-4, A-2	0-5	85-100	80-95	50-85	25-60	20-30	5-10
Sunburg	0-9	Loam	CL-ML, CL	A-4, A-6	0-5	85-95	75-95	75-90	50-75	20-35	5-15
	9-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
848*: Urban land.											
Osakis	0-9	Loam	ML, CL, CL-ML	A-4	0	95-100	85-100	80-95	50-75	20-35	2-10
	9-19	Loam, sandy loam	SM, ML, CL-ML, SM-SC	A-4	0	95-100	85-100	55-90	36-70	20-35	1-10
	19-60	Coarse sand, gravelly coarse sand, very gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0	30-95	20-80	10-50	0-10	<20	NP
850*: Urban land.											
Dassel	0-11	Sandy loam	SM	A-4	0	100	95-100	70-85	40-50	<30	NP-4
	11-28	Stratified loamy fine sand to fine sandy loam.	SM	A-4, A-2	0	100	95-100	60-75	30-40	<30	NP-4
	28-60	Stratified loamy sand to gravelly coarse sand.	SM, SP-SM	A-2	0	100	80-100	50-80	10-35	---	NP
865B*: Urban land.											
Hubbard	0-14	Loamy sand	SM, SP-SM	A-2	0	98-100	95-100	50-80	10-25	<20	NP
	14-48	Sand, coarse sand, loamy sand.	SP-SM, SW-SM	A-1, A-3, A-2-4	0	98-100	70-100	25-75	5-12	<20	NP
	48-60	Sand, coarse sand	SP, SW	A-1, A-3	0	95-100	70-100	20-70	2-5	<20	NP
873*:											
Prebish	0-18	Loam	ML, CL-ML	A-4	0-2	95-100	90-100	75-90	50-75	20-35	3-10
	18-47	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	80-95	77-90	45-80	25-50	<20	NP-4
	47-60	Sandy loam, fine sandy loam.	SM	A-2	0-10	80-95	77-85	55-70	20-35	<20	NP-4

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
873*:											
Nokay	0-12	Sandy loam	SM	A-2, A-4	0-2	90-100	80-100	55-85	25-50	<25	NP-4
	12-24	Sandy loam, fine sandy loam, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	20-30	2-7
	24-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4
875B*:											
Estherville	0-15	Sandy loam	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	15-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
Hawick	0-10	Loamy sand	SM, SP-SM	A-1, A-2	0-5	85-100	80-95	40-70	10-25	---	NP
	10-19	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	19-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
954C*, 954D*:											
Ves	0-12	Loam	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	12-26	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	26-60	Loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Storden	0-7	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
999B*, 999C*, 999D*:											
Ves	0-12	Loam	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	12-26	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	26-60	Loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Estherville	0-15	Sandy loam	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	15-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
1013*. Pits											
1015. Psamments											
1016. Udorthents											
1018. Udifluvents											
1029*. Pits											
1055*: Histosols.											

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
1055*: Aquolls.											
1064*: Rock outcrop.											
Lithic Eutrochrepts.											
1805------------- Blue Earth Variant	0-28	Mucky silt loam	OL	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	28-34	Loam-------------	CL-ML, CL	A-6, A-4	0	95-100	90-100	80-100	70-95	25-40	4-15
	34-60	Gravelly loamy coarse sand, gravelly coarse sand.	SP-SM	A-1	2-10	70-95	55-90	15-40	5-10	<20	NP
1825C------------ Seelyeville	0-60	Muck-------------	PT	A-8	0	---	---	---	---	---	---
1828------------- Glencoe	0-12	Muck-------------	PT	A-8	0	---	---	---	---	---	---
	12-60	Loam, clay loam	CL	A-6, A-7	0	98-100	90-98	80-98	70-85	35-50	15-25
1842F*: Cushing---------	0-12	Sandy loam-------	SM, SM-SC, ML, CL-ML	A-4, A-2, A-1	0-7	75-100	75-100	45-95	20-65	<25	2-7
	12-19	Loam, silt loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-7	75-100	75-100	35-100	12-90	<23	NP-6
	19-31	Loam, sandy clay loam, sandy loam.	SC, CL	A-2, A-4, A-6	0-7	75-100	75-100	45-95	20-75	25-40	9-21
	31-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-2, A-4, A-6, A-1	0-7	75-100	75-100	45-95	20-75	<34	2-20
Flak------------	0-3	Sandy loam-------	SM	A-2, A-4	0-2	90-100	80-100	60-80	25-45	<22	NP-4
	3-19	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
	19-42	Sandy loam-------	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
	42-60	Sandy loam-------	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
1843C*, 1843E*: Cushing---------	0-12	Sandy loam-------	SM, SM-SC, ML, CL-ML	A-4, A-2, A-1	0-7	75-100	75-100	45-95	20-65	<25	2-7
	12-19	Loam, silt loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-7	75-100	75-100	35-100	12-90	<23	NP-6
	19-31	Loam, sandy clay loam, sandy loam.	SC, CL	A-2, A-4, A-6	0-7	75-100	75-100	45-95	20-75	25-40	9-21
	31-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-2, A-4, A-6, A-1	0-7	75-100	75-100	45-95	20-75	<34	2-20
DeMontreville---	0-28	Loamy sand-------	SM	A-2	0-5	90-100	85-100	65-80	20-35	<20	NP
	28-45	Sandy loam, sandy clay loam, loam.	SC, SM, CL, ML	A-2, A-4	0-5	80-100	70-90	55-70	20-55	15-25	3-10
	45-60	Sandy loam, coarse sandy loam.	SC, SM, SM-SC	A-2, A-4	0-5	80-100	70-90	45-65	25-45	15-25	3-8
1879------------- Seelyeville	0-60	Muck-------------	PT	A-8	0	---	---	---	---	---	---
	4-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
1880------------- Martisco	0-9	Mucky silt loam	OL	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	9-70	Marl-------------	---	---	0	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
1892-------------- Prebish	0-13	Fine sandy loam	SM	A-4	0-2	90-100	90-100	55-80	35-50	<20	NP-4
	13-42	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	80-95	77-90	45-80	25-50	<20	NP-4
	42-60	Sandy loam, fine sandy loam.	SM	A-2	0-10	80-95	77-85	55-70	20-35	<20	NP-4
1902B------------- Jewett	0-13	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	90-100	70-90	20-30	3-10
	13-30	Loam, silt loam	CL	A-6	0-10	100	85-95	75-100	50-90	25-40	10-20
	30-60	Fine sandy loam, loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0-10	85-100	85-95	75-85	40-65	20-35	5-20

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
5A, 5B----------- Dakota	0-27	14-27	1.40-1.50	0.6-2.0	0.19-0.24	5.1-7.3	Low-----------	0.28	4	5	2-4
	27-45	4-11	1.55-1.65	2.0-6.0	0.05-0.14	5.1-7.3	Low-----------	0.17			
	45-60	1-4	1.55-1.65	6.0-20	0.02-0.04	5.1-7.8	Low-----------	0.17			
7A, 7B, 7C-------- Hubbard	0-14	4-10	1.45-1.60	6.0-20	0.08-0.12	5.1-7.3	Low-----------	0.15	5	2	.5-1
	14-48	1-5	1.55-1.65	6.0-20	0.03-0.07	5.1-7.3	Low-----------	0.15			
	48-60	0-5	1.55-1.65	6.0-20	0.03-0.07	6.1-7.3	Low-----------	0.15			
25--------------- Becker	0-16	5-18	1.45-1.55	2.0-6.0	0.16-0.20	5.6-7.3	Low-----------	0.20	4	3	2-5
	16-33	5-18	1.45-1.55	2.0-6.0	0.15-0.20	5.6-7.3	Low-----------	0.20			
	33-47	2-10	1.55-1.65	6.0-20	0.05-0.10	6.1-7.8	Low-----------	0.15			
	47-60	1-10	1.60-1.70	6.0-20	0.02-0.07	6.1-7.8	Low-----------	0.15			
32B, 32C, 32E, 32F------------- Nebish	0-9	5-18	1.35-1.50	2.0-6.0	0.13-0.18	6.1-7.3	Low-----------	0.24	5	3	1-2
	9-31	18-35	1.50-1.65	0.6-2.0	0.15-0.19	6.1-7.8	Moderate-----	0.32			
	31-60	10-27	1.50-1.70	0.6-2.0	0.11-0.19	7.4-8.4	Low-----------	0.32			
35--------------- Blue Earth	0-6	18-32	0.20-0.80	0.6-6.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	5	10-25
	6-38	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Low-----------	0.28			
	38-60	18-32	1.30-1.60	0.2-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.28			
36--------------- Flom	0-9	22-35	1.30-1.45	0.2-2.0	0.18-0.24	6.1-7.8	Moderate-----	0.28	5	6	5-8
	9-24	24-35	1.45-1.60	0.2-0.6	0.15-0.19	6.6-8.4	Moderate-----	0.28			
	24-60	24-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	Moderate-----	0.28			
38B, 38C, 38D---- Waukon	0-7	12-30	1.25-1.40	0.2-2.0	0.17-0.24	6.1-7.3	Moderate-----	0.24	5	6	4-6
	7-14	18-35	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	Moderate-----	0.32			
	14-60	12-30	1.45-1.65	0.6-2.0	0.11-0.19	7.4-8.4	Moderate-----	0.32			
41A, 41B, 41C---- Estherville	0-15	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low-----------	0.20	3	3	2-4
	15-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	Low-----------	0.10			
69B-------------- Fedji	0-12	2-10	1.40-1.55	6.0-20	0.10-0.13	5.6-6.5	Low-----------	0.17	5	2	2-3
	12-27	2-10	1.45-1.65	6.0-20	0.09-0.11	6.1-7.3	Low-----------	0.17			
	27-40	18-30	1.50-1.70	0.6-2.0	0.17-0.19	6.1-7.3	Low-----------	0.32			
	40-60	16-30	1.55-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.32			
72--------------- Shooker	0-15	8-20	1.20-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Low-----------	0.32	5	5	2-4
	15-36	18-35	1.40-1.60	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-----	0.32			
	36-60	12-25	1.40-1.65	0.6-2.0	0.11-0.19	7.4-8.4	Low-----------	0.32			
75--------------- Bluffton	0-19	14-25	1.25-1.40	0.6-2.0	0.20-0.24	5.6-6.5	Low-----------	0.28	5	5	3-7
	19-33	18-30	1.45-1.55	0.6-6.0	0.15-0.17	5.6-7.3	Low-----------	0.28			
	33-60	18-30	1.50-1.65	0.2-0.6	0.15-0.19	7.4-8.4	Low-----------	0.28			
109-------------- Cordova	0-13	15-30	1.25-1.45	0.2-2.0	0.18-0.22	6.1-7.3	Moderate-----	0.28	5	6	4-7
	13-30	28-35	1.35-1.50	0.2-0.6	0.15-0.19	5.1-6.5	Moderate-----	0.28			
	30-60	18-30	1.45-1.70	0.6-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.28			
114-------------- Glencoe	0-16	25-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	Moderate-----	0.28	5	6	5-10
	16-55	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	Moderate-----	0.28			
	55-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Moderate-----	0.28			
119B------------- Pomroy	0-9	2-8	1.45-1.55	6.0-20	0.07-0.10	5.1-6.0	Low-----------	0.15	4	1	.5-1
	9-25	2-10	1.50-1.70	6.0-20	0.06-0.11	5.1-6.0	Low-----------	0.15			
	25-29	2-12	1.50-1.70	6.0-20	0.05-0.10	5.1-6.0	Low-----------	0.15			
	29-60	5-18	1.75-2.00	0.2-0.6	0.08-0.12	5.6-7.3	Low-----------	0.28			
125-------------- Beltrami	0-15	6-18	1.30-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.32	5	5	1-2
	15-35	18-35	1.50-1.65	0.6-2.0	0.15-0.19	6.1-7.8	Moderate-----	0.32			
	35-60	16-27	1.50-1.70	0.6-2.0	0.11-0.19	7.4-8.4	Low-----------	0.32			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
129-------------- Cylinder	0-14	22-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6	4-5
	14-26	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32			
	26-60	2-12	1.60-1.70	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
133B------------- Dalbo	0-14	20-27	1.25-1.45	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.43	3	6	2-4
	14-30	35-60	1.25-1.45	0.06-0.6	0.10-0.18	5.1-7.3	High---------	0.32			
	30-60	27-60	1.30-1.60	0.2-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.32			
142-------------- Nokay	0-12	4-12	1.40-1.60	2.0-6.0	0.13-0.18	4.5-5.5	Low----------	0.28	5	3	.5-2
	12-24	10-18	1.45-1.70	0.6-6.0	0.12-0.19	5.1-6.5	Low----------	0.28			
	24-60	5-18	1.75-2.00	0.2-0.6	0.07-0.12	5.1-7.3	Low----------	0.28			
144B, 144C, 144E- Flak	0-3	8-18	1.40-1.60	2.0-6.0	0.13-0.18	5.1-6.5	Low----------	0.24	3	3	.5-1
	3-19	8-18	1.45-1.65	2.0-6.0	0.12-0.16	5.1-6.5	Low----------	0.24			
	19-42	8-18	1.75-1.90	0.2-0.6	0.07-0.12	5.1-6.5	Low----------	0.24			
	42-60	6-18	1.80-2.00	0.2-0.6	0.07-0.12	5.6-6.5	Low----------	0.24			
155B------------- Chetek	0-13	5-12	1.35-1.70	2.0-6.0	0.11-0.15	5.1-6.5	Low----------	0.24	3	3	.5-1
	13-23	10-18	1.65-1.75	2.0-6.0	0.10-0.19	5.1-6.5	Low----------	0.24			
	23-60	1-6	1.50-1.60	>6.0	0.02-0.04	5.1-6.5	Low----------	0.10			
156A, 156B------- Fairhaven	0-15	18-30	1.25-1.40	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.32	4	6	3-6
	15-30	18-30	1.30-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.43			
	30-60	0-5	1.55-1.65	6.0-20	0.02-0.04	6.1-8.4	Low----------	0.10			
159B------------- Anoka	0-14	2-10	1.40-1.60	2.0-20	0.13-0.16	5.6-6.5	Low----------	0.17	5	2	.5-1
	14-36	2-10	1.45-1.70	0.6-6.0	0.10-0.16	5.1-6.5	Low----------	0.17			
	36-75	2-5	1.45-1.75	2.0-20	0.06-0.12	6.1-7.3	Low----------	0.17			
163B------------- Brainerd	0-15	8-18	1.40-1.60	2.0-6.0	0.13-0.18	4.5-6.0	Low----------	0.28	4	3	.5-2
	15-22	8-18	1.45-1.65	2.0-6.0	0.12-0.16	4.5-6.0	Low----------	0.28			
	22-55	8-18	1.75-1.95	0.2-0.6	0.07-0.12	5.1-6.5	Low----------	0.28			
	55-60	6-18	1.75-2.00	0.2-0.6	0.07-0.12	5.6-7.3	Low----------	0.28			
179B------------- Langola	0-19	4-10	1.35-1.50	6.0-20	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	3-5
	19-38	2-10	1.45-1.60	6.0-20	0.08-0.11	5.6-6.5	Low----------	0.17			
	38-60	6-12	1.70-1.90	0.2-0.6	0.11-0.16	6.1-7.3	Low----------	0.32			
180A, 180B------- Gonvick	0-12	10-32	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.24	5	6	4-5
	12-25	22-35	1.35-1.50	0.6-2.0	0.15-0.19	6.6-7.3	Moderate-----	0.32			
	25-60	12-35	1.40-1.60	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32			
181-------------- Litchfield	0-19	5-10	1.30-1.50	2.0-6.0	0.10-0.12	6.1-7.3	Low----------	0.17	5	2	2-4
	19-43	5-10	1.40-1.65	2.0-6.0	0.07-0.16	5.1-6.5	Low----------	0.17			
	43-60	1-8	1.45-1.65	2.0-6.0	0.08-0.10	6.1-7.8	Low----------	0.17			
183-------------- Dassel	0-11	6-18	1.30-1.45	2.0-6.0	0.16-0.20	5.6-7.3	Low----------	0.20	5	3	3-8
	11-28	2-6	1.40-1.60	2.0-6.0	0.12-0.17	5.6-7.3	Low----------	0.20			
	28-60	2-8	1.45-1.65	6.0-20	0.08-0.10	6.1-7.8	Low----------	0.20			
200B, 200C------- Holdingford	0-12	7-15	1.30-1.50	0.6-2.0	0.13-0.15	5.1-7.3	Low----------	0.24	5	3	1-3
	12-37	10-18	1.60-1.80	0.6-2.0	0.12-0.19	5.1-7.3	Low----------	0.24			
	37-60	9-14	1.60-1.80	0.6-2.0	0.12-0.14	7.4-8.4	Low----------	0.24			
204B, 204C, 204E- Cushing	0-12	6-14	1.35-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low----------	0.24	5	3	1-2
	12-19	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low----------	0.32			
	19-31	18-27	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low----------	0.32			
	31-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low----------	0.32			
207B, 207C, 207E- Nymore	0-9	2-12	1.45-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	.5-1
	9-60	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-6.5	Low----------	0.17			
218-------------- Watab	0-14	3-12	1.45-1.55	6.0-20	0.10-0.12	5.1-6.0	Low----------	0.17	4	2	.5-2
	14-20	1-12	1.45-1.65	2.0-20	0.08-0.12	5.1-6.0	Low----------	0.17			
	20-24	3-12	1.55-1.75	2.0-6.0	0.12-0.17	5.1-6.5	Low----------	0.28			
	24-60	5-15	1.80-2.00	0.2-0.6	0.08-0.12	5.1-7.3	Low----------	0.28			
233B------------- Growton	0-11	7-11	1.35-1.55	2.0-6.0	0.13-0.16	5.1-7.3	Low----------	0.24	5	3	1-3
	11-37	10-18	1.55-1.70	0.6-2.0	0.12-0.19	5.1-7.3	Low----------	0.32			
	37-60	9-18	1.60-1.75	0.6-2.0	0.12-0.17	7.4-8.4	Low----------	0.32			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
								K	T		
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
236------------- Vallers	0-8	20-27	1.20-1.35	0.2-0.6	0.18-0.22	7.4-8.4	Moderate-----	0.28	5	4L	5-8
	8-15	18-35	1.40-1.55	0.2-0.6	0.15-0.19	7.9-8.4	Moderate-----	0.28			
	15-60	18-35	1.50-1.70	0.2-0.6	0.17-0.19	7.4-8.4	Low----------	0.28			
255------------- Mayer	0-24	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	4	4L	4-8
	24-40	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low----------	0.28			
	40-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.15			
260------------- Duelm	0-19	2-10	1.40-1.60	6.0-20	0.08-0.12	5.6-7.3	Low----------	0.15	5	2	5-1
	19-30	1-8	1.55-1.65	6.0-20	0.06-0.11	5.1-7.3	Low----------	0.15			
	30-60	0-6	1.55-1.65	6.0-20	0.02-0.07	5.6-7.3	Low----------	0.15			
261------------- Isan	0-20	2-8	1.30-1.60	6.0-20	0.08-0.12	5.6-6.5	Low----------	0.17	5	2	3-4
	20-60	1-5	1.55-1.70	6.0-20	0.04-0.06	5.6-7.3	Low----------	0.17			
281------------- Darfur	0-17	13-20	1.30-1.50	0.6-2.0	0.15-0.17	6.1-7.3	Low----------	0.20	5	3	4-6
	17-30	13-18	1.35-1.50	2.0-6.0	0.15-0.17	6.6-7.8	Low----------	0.20			
	30-60	5-15	1.45-1.60	2.0-6.0	0.08-0.10	6.6-8.4	Low----------	0.20			
292B------------ Alstad	0-13	7-14	1.50-1.60	0.6-2.0	0.13-0.18	5.1-7.3	Low----------	0.24	5	3	1-3
	13-35	18-28	1.55-1.70	0.6-2.0	0.13-0.19	5.6-7.8	Low----------	0.32			
	35-60	8-23	1.60-1.80	0.2-0.6	0.09-0.19	6.1-8.4	Low----------	0.32			
318------------- Mayer	0-22	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	4	4L	4-8
	22-29	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low----------	0.28			
	29-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.15			
325------------- Prebish	0-18	5-20	1.35-1.55	2.0-6.0	0.16-0.18	5.6-7.3	Low----------	0.20	5	3	4-8
	18-42	12-18	1.50-1.70	0.2-2.0	0.14-0.16	5.6-7.3	Low----------	0.28			
	42-60	2-15	1.65-1.90	0.2-0.6	0.09-0.13	5.6-8.4	Low----------	0.28			
327A, 327B------- Dickman	0-19	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low----------	0.20	3	3	2-5
	19-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low----------	0.15			
392------------- Biscay	0-16	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6	4-8
	16-26	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28			
	26-60	1-6	1.55-1.65	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10			
399------------- Biscay	0-16	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6	4-8
	16-41	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28			
	41-60	1-6	1.55-1.65	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10			
406B, 406C, 406E- Dorset	0-10	4-18	1.40-1.55	2.0-6.0	0.13-0.15	5.6-7.3	Low----------	0.24	3	3	1-3
	10-19	10-18	1.45-1.65	2.0-6.0	0.12-0.19	5.6-7.3	Low----------	0.24			
	19-23	5-10	1.55-1.65	6.0-20	0.06-0.10	5.6-7.8	Low----------	0.10			
	23-60	0-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10			
413------------- Osakis	0-9	10-22	1.20-1.40	0.6-2.0	0.18-0.22	6.1-7.3	Low----------	0.28	3	5	2-4
	9-19	8-18	1.30-1.50	0.6-6.0	0.14-0.19	6.1-7.3	Low----------	0.28			
	19-60	0-5	1.50-1.70	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10			
414------------- Hamel	0-12	20-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.28	5	6	5-7
	12-36	24-35	1.45-1.60	0.2-0.6	0.16-0.19	5.6-7.3	Moderate-----	0.28			
	36-60	20-30	1.55-1.75	0.6-2.0	0.14-0.18	7.4-7.8	Moderate-----	0.28			
421B, 421C------- Ves	0-12	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low----------	0.24	5	6	2-6
	12-26	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.24			
	26-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
446A, 446B------- Normania	0-14	22-32	1.20-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.24	5	6	4-8
	14-26	22-32	1.30-1.40	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.24			
	26-60	22-27	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
453B, 453C------- DeMontreville	0-28	2-6	1.50-1.68	6.0-20	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	.5-1
	28-45	6-22	1.70-1.82	0.2-0.6	0.12-0.19	5.6-6.5	Low----------	0.28			
	45-60	5-10	1.75-1.85	0.2-0.6	0.10-0.13	5.6-7.3	Low----------	0.28			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
454B, 454C, 454E, 454F------------ Mahtomedi	0-5	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low-----------	0.15	5	2	<1
	5-25	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low-----------	0.10			
	25-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low-----------	0.10			
459-------------- Corunna	0-8	5-15	1.60-1.70	0.6-6.0	0.14-0.22	6.1-7.8	Low-----------	0.20	4	3	1-2
	8-32	10-18	1.30-1.60	0.6-6.0	0.08-0.14	6.1-7.8	Low-----------	0.20			
	32-60	18-35	1.45-1.70	0.2-0.6	0.16-0.20	7.4-8.4	Moderate-----	0.43			
461B, 461C-------- Koronis	0-8	10-20	1.20-1.40	2.0-6.0	0.20-0.22	5.6-7.3	Low-----------	0.20	5	5	1-4
	8-27	20-35	1.30-1.50	0.6-6.0	0.15-0.19	5.6-7.3	Low-----------	0.28			
	27-60	12-20	1.35-1.60	2.0-6.0	0.11-0.16	7.4-8.4	Low-----------	0.28			
465-------------- Kalmarville	0-42	8-15	1.35-1.50	2.0-6.0	0.13-0.18	6.6-7.8	Low-----------	0.20	5	3	2-4
	42-60	2-5	1.55-1.65	6.0-20	0.06-0.09	6.6-7.8	Low-----------	0.10			
511-------------- Marcellon	0-15	13-20	1.25-1.35	0.6-2.0	0.17-0.24	5.6-6.5	Low-----------	0.28	5	5	3-7
	15-32	20-24	1.45-1.55	0.6-2.0	0.13-0.19	5.6-7.8	Moderate-----	0.28			
	32-60	6-12	1.55-1.65	2.0-6.0	0.08-0.15	7.4-8.4	Low-----------	0.28			
525-------------- Muskego	0-31	2-4	0.10-0.21	0.2-6.0	0.35-0.45	5.6-7.3	--------------	----	2	3	50-77
	31-60	---	0.10-0.40	0.06-0.2	0.18-0.24	6.6-8.4	--------------	----			
540-------------- Seelyeville	0-10	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-7.3	--------------	----	---	3	>25
	10-60	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-7.3	--------------	----			
541-------------- Rifle	0-8	---	0.20-0.35	>0.2	0.45-0.65	5.6-7.3	--------------	----	---	3	---
	8-60	---	0.08-0.20	0.6-6.0	0.45-0.55	5.6-7.3	--------------	----			
543-------------- Markey	0-25	---	0.15-0.45	0.2-6.0	0.35-0.45	5.6-7.8	--------------	----	2	2	55-85
	25-60	0-10	1.40-1.65	6.0-20	0.03-0.08	5.6-8.4	Low-----------	----			
544-------------- Cathro	0-14	---	0.28-0.45	0.2-6.0	0.45-0.55	5.6-7.8	--------------	----	2	2	60-85
	14-40	---	0.15-0.30	0.2-6.0	0.35-0.45	5.6-7.8	--------------	----			
	40-60	10-25	1.50-1.70	0.2-2.0	0.11-0.22	6.6-8.4	Low-----------	----			
565-------------- Eckvoll	0-9	5-15	1.30-1.70	2.0-6.0	0.10-0.12	6.1-7.3	Low-----------	0.17	5	2	.5-1
	9-22	2-10	1.30-1.80	2.0-6.0	0.06-0.08	6.1-7.3	Low-----------	0.17			
	22-40	18-35	1.40-1.80	0.6-2.0	0.16-0.18	6.6-7.8	Moderate-----	0.32			
	40-60	18-32	1.30-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32			
566-------------- Regal	0-15	18-30	1.20-1.40	0.6-2.0	0.17-0.22	6.6-8.4	Low-----------	0.24	3	6	6-9
	15-18	15-27	1.30-1.55	0.6-2.0	0.15-0.20	7.4-8.4	Low-----------	0.24			
	18-60	0-5	1.50-1.65	6.0-20	0.02-0.06	7.4-8.4	Low-----------	0.10			
571-------------- Coriff	0-18	12-20	1.30-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L	6-10
	18-24	10-18	1.35-1.45	2.0-6.0	0.12-0.14	6.6-7.8	Low-----------	0.20			
	24-34	1-10	1.50-1.70	6.0-20	0.09-0.14	6.6-7.8	Low-----------	0.20			
	34-60	18-27	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
572-------------- Lowlein	0-13	10-18	1.30-1.50	2.0-6.0	0.13-0.15	6.1-7.3	Low-----------	0.20	5	3	4-7
	13-21	10-18	1.35-1.45	2.0-6.0	0.12-0.14	6.1-7.3	Low-----------	0.24			
	21-30	1-10	1.55-1.65	6.0-20	0.06-0.11	6.1-7.3	Low-----------	0.15			
	30-60	18-27	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
582-------------- Roliss	0-14	18-35	1.10-1.50	0.2-2.0	0.17-0.24	6.6-7.8	Moderate-----	0.28	5	6	3-8
	14-22	18-35	1.30-1.70	0.2-0.6	0.15-0.19	6.6-7.8	Moderate-----	0.28			
	22-60	18-35	1.30-1.70	0.2-2.0	0.15-0.19	7.9-8.4	Moderate-----	0.28			
591B------------- Doland	0-9	18-27	1.30-1.45	0.6-2.0	0.24-0.28	6.1-7.3	Low-----------	0.32	5	6	4-6
	9-24	18-27	1.35-1.50	0.6-2.0	0.17-0.22	6.1-7.3	Low-----------	0.32			
	24-60	18-30	1.45-1.70	0.6-2.0	0.14-0.19	6.6-8.4	Low-----------	0.32			
597-------------- Tara	0-23	18-30	1.40-1.50	0.6-2.0	0.20-0.24	6.1-7.3	Low-----------	0.28	5	6	4-8
	23-35	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-7.8	Low-----------	0.28			
	35-60	18-30	1.35-1.60	0.6-2.0	0.15-0.19	7.4-8.4	Low-----------	0.37			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
611C, 611D-------Hawick	0-10	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low-----------	0.17	3	2	1-3
	10-19	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low-----------	0.10			
	19-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low-----------	0.10			
639A, 639B-------Ridgeport	0-13	10-18	1.50-1.55	2.0-6.0	0.14-0.17	5.6-7.3	Low-----------	0.24	4	3	1-2
	13-34	10-18	1.55-1.60	2.0-6.0	0.10-0.14	5.6-7.3	Low-----------	0.24			
	34-60	2-8	1.60-1.75	>20	0.03-0.05	7.4-8.4	Low-----------	0.10			
804D*:											
Koronis----------	0-8	10-20	1.20-1.40	2.0-6.0	0.20-0.22	5.6-7.3	Low-----------	0.20	5	5	4-5
	8-27	20-35	1.30-1.50	0.6-6.0	0.15-0.19	5.6-7.3	Low-----------	0.28			
	27-60	12-20	1.35-1.60	2.0-6.0	0.11-0.16	7.4-8.4	Low-----------	0.28			
Estherville-----	0-15	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low-----------	0.20	3	3	2-4
	15-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low-----------	0.20			
	18-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	Low-----------	0.10			
807D*:											
Koronis----------	0-8	10-20	1.20-1.40	2.0-6.0	0.20-0.22	5.6-7.3	Low-----------	0.20	5	5	4-5
	8-27	20-35	1.30-1.50	0.6-6.0	0.15-0.19	5.6-7.3	Low-----------	0.28			
	27-60	12-20	1.35-1.60	2.0-6.0	0.11-0.16	7.4-8.4	Low-----------	0.28			
Sunburg----------	0-9	14-22	1.30-1.50	0.6-2.0	0.20-0.22	6.6-8.4	Low-----------	0.24	5	4L	1-4
	9-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low-----------	0.24			
848*:											
Urban land.											
Osakis-----------	0-9	10-22	1.20-1.40	0.6-2.0	0.18-0.22	6.1-7.3	Low-----------	0.28	3	5	2-4
	9-19	8-18	1.30-1.50	0.6-6.0	0.14-0.19	6.1-7.3	Low-----------	0.28			
	19-60	0-5	1.50-1.70	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
850*:											
Urban land.											
Dassel-----------	0-11	6-18	1.30-1.45	2.0-6.0	0.16-0.20	5.6-7.3	Low-----------	0.20	5	3	3-8
	11-28	2-6	1.40-1.60	2.0-6.0	0.12-0.17	5.6-7.3	Low-----------	0.20			
	28-60	2-8	1.45-1.65	6.0-20	0.08-0.10	6.1-7.8	Low-----------	0.20			
865B*:											
Urban land.											
Hubbard----------	0-14	4-10	1.45-1.60	6.0-20	0.08-0.12	5.1-7.3	Low-----------	0.15	5	2	2-5
	14-48	1-5	1.55-1.65	6.0-20	0.03-0.07	5.1-7.3	Low-----------	0.15			
	48-60	0-5	1.55-1.65	6.0-20	0.03-0.07	6.1-7.3	Low-----------	0.15			
873*:											
Prebish----------	0-18	15-27	1.30-1.45	0.6-2.0	0.18-0.22	5.6-7.3	Low-----------	0.28	5	6	4-8
	18-47	12-18	1.50-1.70	0.2-2.0	0.14-0.16	5.6-7.3	Low-----------	0.28			
	47-60	2-15	1.65-1.90	0.2-0.6	0.09-0.13	5.6-8.4	Low-----------	0.28			
Nokay------------	0-12	4-12	1.40-1.60	2.0-6.0	0.13-0.18	4.5-5.5	Low-----------	0.28	5	3	.5-2
	12-24	10-18	1.45-1.70	0.6-6.0	0.12-0.19	5.1-6.5	Low-----------	0.28			
	24-60	5-18	1.75-2.00	0.2-0.6	0.07-0.12	5.1-7.3	Low-----------	0.28			
875B*:											
Estherville-----	0-15	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low-----------	0.20	3	3	2-4
	15-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low-----------	0.20			
	18-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	Low-----------	0.10			
Hawick-----------	0-10	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low-----------	0.17	3	2	1-3
	10-19	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low-----------	0.10			
	19-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low-----------	0.10			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
954C*, 954D*:											
Ves	0-12	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-6
	12-26	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	Moderate	0.24			
	26-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Storden	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
	7-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
999B*, 999C*, 999D*:											
Ves	0-12	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-6
	12-26	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	Moderate	0.24			
	26-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Estherville	0-15	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low	0.20	3	3	2-4
	15-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low	0.20			
	18-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	Low	0.10			
1013*. Pits											
1015. Psamments											
1016. Udorthents											
1018. Udifluvents											
1029*. Pits											
1055*: Histosols.											
Aquolls.											
1064*: Rock outcrop.											
Lithic Eutrochrepts.											
1805 Blue Earth Variant	0-28	12-27	0.20-0.80	2.0-6.0	0.35-0.48	7.4-8.4	Low	0.28	5	5	10-25
	28-34	7-20	0.80-1.40	0.6-2.0	0.17-0.20	7.4-8.4	Low	0.28			
	34-60	3-10	1.50-1.65	6.0-20	0.02-0.04	6.1-8.4	Low	0.10			
1825C Seelyeville	0-60	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-7.3	-------	0.10	5	3	>25
1828 Glencoe	0-12	---	0.10-0.25	0.2-6.0	0.35-0.45	6.1-7.8	-------	0.10	5	3	>25
	12-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Moderate	0.28			
1842F*:											
Cushing	0-12	6-14	1.35-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low	0.24	5	3	1-2
	12-19	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low	0.32			
	19-31	18-27	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low	0.32			
	31-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low	0.32			
Flak	0-3	8-18	1.40-1.60	2.0-6.0	0.13-0.18	5.1-6.5	Low	0.24	3	3	.5-1
	3-19	8-18	1.45-1.65	2.0-6.0	0.12-0.16	5.1-6.5	Low	0.24			
	19-42	8-18	1.75-1.90	0.2-0.6	0.07-0.12	5.1-6.5	Low	0.24			
	42-60	6-18	1.80-2.00	0.2-0.6	0.07-0.12	5.6-6.5	Low	0.24			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
1843C*, 1843E*:											
Cushing----------	0-12	6-14	1.35-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low-----------	0.24	5	3	1-2
	12-19	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low-----------	0.32			
	19-31	18-27	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low-----------	0.32			
	31-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low-----------	0.32			
DeMontreville---	0-28	2-6	1.50-1.68	6.0-20	0.10-0.12	5.6-7.3	Low-----------	0.17	5	2	.5-1
	28-45	6-22	1.70-1.82	0.2-0.6	0.12-0.19	5.6-6.5	Low-----------	0.28			
	45-60	5-10	1.75-1.85	0.2-0.6	0.10-0.13	5.6-7.3	Low-----------	0.28			
1879-------------- Seelyeville	0-60	---	0.10-0.25	0.2-6.0	0.35-0.45	7.4-8.4	--------------	----	---	3	>25
	4-60	---	0.10-0.25	0.2-6.0	0.35-0.45	7.4-8.4	--------------	----			
1880-------------- Martisco	0-9	---	0.13-0.23	0.6-6.0	0.35-0.45	6.1-8.4	--------------	----	---	2	>25
	9-70	---	---	0.06-0.2	---	7.9-8.4	Low-----------	----			
1892-------------- Prebish	0-13	5-20	1.35-1.55	2.0-6.0	0.16-0.18	5.6-7.3	Low-----------	0.20	5	3	3-6
	13-42	12-18	1.50-1.70	0.2-2.0	0.14-0.16	5.6-7.3	Low-----------	0.28			
	42-60	2-15	1.65-1.90	0.2-0.6	0.09-0.13	5.6-8.4	Low-----------	0.28			
1902B------------- Jewett	0-13	10-20	1.35-1.55	0.6-2.0	0.22-0.24	5.1-7.3	Low-----------	0.32	5	5	.5-1
	13-30	18-25	1.55-1.65	0.6-2.0	0.18-0.22	5.1-6.0	Moderate------	0.32			
	30-60	18-25	1.40-1.70	0.6-2.0	0.12-0.19	5.1-6.0	Moderate------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
5A, 5B Dakota	B	None	---	---	>6.0	---	---
7A, 7B, 7C Hubbard	A	None	---	---	>6.0	---	---
25 Becker	B	Rare	---	---	>4.0	Apparent	Nov-May
32B, 32C, 32E, 32F Nebish	B	None	---	---	>6.0	---	---
35* Blue Earth	B/D	Rare	---	---	+2-1.0	Apparent	Jan-Dec
36* Flom	B/D	Rare	---	---	+1-3.0	Apparent	Jan-Dec
38B, 38C, 38D Waukon	B	None	---	---	>6.0	---	---
41A, 41B, 41C Estherville	B	None	---	---	>6.0	---	---
69B Fedji	A	None	---	---	>6.0	---	---
72 Shooker	C	None	---	---	1.0-3.0	Apparent	Nov-Jul
75* Bluffton	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec
109 Cordova	C/D	None	---	---	1.0-3.0	Apparent	Nov-May
114* Glencoe	B/D	None	---	---	+1-1.0	Apparent	Oct-Jun
119B Pomroy	C	None	---	---	>6.0	---	---
125 Beltrami	B	None	---	---	2.0-4.0	Apparent	Nov-Jun
129 Cylinder	B	None	---	---	2.0-4.0	Apparent	Nov-Jul
133B Dalbo	B	None	---	---	3.0-6.0	Apparent	Nov-May
142 Nokay	C	None	---	---	1.0-3.0	Perched	Apr-May
144B, 144C, 144E Flak	C	None	---	---	>6.0	---	---
155B Chetek	B	None	---	---	>6.0	---	---
156A, 156B Fairhaven	B	None	---	---	>6.0	---	---
159B Anoka	B	None	---	---	>6.0	---	---

See footnote at end of table.

TABLE 16.--WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months
					Ft		
163B------------------- Brainerd	C	None------------	---	---	1.5-2.5	Perched	Apr-May
179B------------------- Langola	B	None------------	---	---	>6.0	---	---
180A, 180B------------- Gonvick	B	None------------	---	---	2.5-6.0	Apparent	Nov-Jun
181-------------------- Litchfield	A	None------------	---	---	2.5-5.0	Apparent	Apr-May
183-------------------- Dassel	B/D	None------------	---	---	0.5-3.0	Apparent	Oct-Jun
200B, 200C------------- Holdingford	C	None------------	---	---	>6.0	---	---
204B, 204C, 204E-------- Cushing	B	None------------	---	---	>6.0	---	---
207B, 207C, 207E-------- Nymore	A	None------------	---	---	>6.0	---	---
218-------------------- Watab	C	None------------	---	---	1.5-3.0	Perched	Mar-Jun
233B------------------- Growton	B	None------------	---	---	3.0-5.0	Apparent	Apr-Jun
236-------------------- Vallers	C	None------------	---	---	1.0-2.5	Apparent	Nov-Jun
255-------------------- Mayer	B/D	None------------	---	---	1.0-3.0	Apparent	Oct-Jun
260-------------------- Duelm	A	None------------	---	---	2.0-5.0	Apparent	Apr-Jun
261*------------------- Isan	A/D	None------------	---	---	+.5-2.0	Apparent	Oct-Jun
281-------------------- Darfur	B/D	None------------	---	---	1.0-3.0	Apparent	Dec-May
292B------------------- Alstad	C	None------------	---	---	1.0-3.0	Perched	Nov-May
318*------------------- Mayer	B/D	Rare------------	---	---	+1-1.0	Apparent	Jan-Dec
325*------------------- Prebish	C/D	None------------	---	---	+1-1.0	Apparent	Jan-Dec
327A, 327B------------- Dickman	A	None------------	---	---	>6.0	---	---
392-------------------- Biscay	B/D	None------------	---	---	1.0-3.0	Apparent	Nov-Jun
399*------------------- Biscay	B/D	None------------	---	---	+1-3.0	Apparent	Jan-Dec
406B, 406C, 406E-------- Dorset	B	None------------	---	---	>6.0	---	---
413-------------------- Osakis	B	None------------	---	---	4.0-6.0	Apparent	Nov-Jun

See footnote at end of table.

TABLE 16.--WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
414-------------------- Hamel	C	None------------	---	---	1.0-3.0	Apparent	Nov-Jun
421B, 421C-------------- Ves	B	None------------	---	---	>6.0	---	---
446A, 446B-------------- Normania	B	None------------	---	---	3.0-6.0	Apparent	Mar-Jun
453B, 453C-------------- DeMontreville	B	None------------	---	---	>6.0	---	---
454B, 454C, 454E, 454F-- Mahtomedi	A	None------------	---	---	>6.0	---	---
459*-------------------- Corunna	B/D	None------------	---	---	+1-2.0	Apparent	Nov-May
461B, 461C-------------- Koronis	B	None------------	---	---	>6.0	---	---
465--------------------- Kalmarville	B/D	Frequent--------	Brief---------	Mar-Jun	0-1.0	Apparent	Mar-Aug
511--------------------- Marcellon	B	Occasional------	Brief---------	Nov-May	1.0-3.0	Apparent	Nov-May
525*-------------------- Muskego	A/D	None------------	---	---	+1-1.0	Apparent	Nov-Aug
540*-------------------- Seelyeville	A/D	None------------	---	---	+2-2.0	Apparent	Jan-Dec
541*-------------------- Rifle	A/D	None------------	---	---	+1-1.0	Apparent	Nov-Jun
543*-------------------- Markey	A/D	None------------	---	---	+1-1.0	Apparent	Nov-Jun
544*-------------------- Cathro	A/D	None------------	---	---	+1-1.0	Apparent	Nov-Jun
565--------------------- Eckvoll	B	None------------	---	---	2.0-5.0	Apparent	Apr-Jun
566--------------------- Regal	B/D	None------------	---	---	1.0-3.0	Apparent	Nov-Jun
571--------------------- Coriff	B/D	None------------	---	---	1.0-3.0	Apparent	Nov-Jun
572--------------------- Lowlein	B	None------------	---	---	3.0-5.0	Apparent	Mar-Jun
582--------------------- Roliss	B/D	None------------	---	---	1.0-3.0	Apparent	Apr-Jul
591B-------------------- Doland	B	None------------	---	---	>6.0	---	---
597--------------------- Tara	B	None------------	---	---	3.0-5.0	Perched	Mar-Jun
611C, 611D-------------- Hawick	A	None------------	---	---	>6.0	---	---
639A, 639B-------------- Ridgeport	B	None------------	---	---	>6.0	---	---

See footnote at end of table.

TABLE 16.--WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months
					Ft		
804D:							
Koronis	B	None	---	---	>6.0	---	---
Estherville	B	None	---	---	>6.0	---	---
807D:							
Koronis	B	None	---	---	>6.0	---	---
Sunburg	B	None	---	---	>6.0	---	---
848:							
Urban land.							
Osakis	B	None	---	---	4.0-6.0	Apparent	Nov-Jun
850:							
Urban land.							
Dassel	B/D	None	---	---	0-1.0	Apparent	Oct-Jun
865B:							
Urban land.							
Hubbard	A	None	---	---	>6.0	---	---
873:							
Prebish*	C/D	None	---	---	+1-1.0	Apparent	Jan-Dec
Nokay	C	None	---	---	1.0-3.0	Perched	Apr-May
875B:							
Estherville	B	None	---	---	>6.0	---	---
Hawick	A	None	---	---	>6.0	---	---
954C, 954D:							
Ves	B	None	---	---	>6.0	---	---
Storden	B	None	---	---	>6.0	---	---
999B, 999C, 999D:							
Ves	B	None	---	---	>6.0	---	---
Estherville	B	None	---	---	>6.0	---	---
1013. Pits							
1015. Psamments							
1016. Udorthents							
1018. Udifluvents							
1029. Pits							
1055:							
Histosols.							
Aquolls.							
1064:							
Rock outcrop.							

See footnote at end of table.

TABLE 16.--WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
1064: Lithic Eutrochrepts.							
1805*: Blue Earth Variant	B/D	None	---	---	+2-1.0	Apparent	Jan-Dec
1825C: Seelyeville	D	None	---	---	0-2.0	Apparent	Jan-Dec
1828*: Glencoe	B/D	None	---	---	+1-1.0	Apparent	Oct-Jun
1842F:							
Cushing	B	None	---	---	>6.0	---	---
Flak	C	None	---	---	>6.0	---	---
1843C, 1843E:							
Cushing	B	None	---	---	>6.0	---	---
DeMontreville	B	None	---	---	>6.0	---	---
1879*: Seelyeville	A/D	Frequent	Long	Nov-May	+2-2.0	Apparent	Jan-Dec
1880*: Martisco	D	Occasional	Long to very long.	Mar-Jun	+1-0.5	Apparent	Oct-Jun
1892*: Prebish	C/D	None	---	---	+1-1.0	Apparent	Jan-Dec
1902B: Jewett	B	None	---	---	>6.0	---	---

* In the "High water table--Depth" column, a plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

TABLE 17.--SOIL FEATURES

[The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
5A, 5B-------------------- Dakota	>60	---	---	---	Moderate--------	Low------------	Moderate.
7A, 7B, 7C--------------- Hubbard	>60	---	---	---	Low------------	Low------------	Low.
25----------------------- Becker	>60	---	---	---	Moderate--------	Low------------	Low.
32B, 32C, 32E, 32F------- Nebish	>60	---	---	---	Moderate--------	Moderate--------	Low.
35----------------------- Blue Earth	>60	---	---	---	High-----------	High-----------	Low.
36----------------------- Flom	>60	---	---	---	High-----------	High-----------	Low.
38B, 38C, 38D------------ Waukon	>60	---	---	---	Moderate--------	Low------------	Low.
41A, 41B, 41C------------ Estherville	>60	---	---	---	Low------------	Low------------	Low.
69B---------------------- Fedji	>60	---	---	---	Low------------	Low------------	Low.
72----------------------- Shooker	>60	---	---	---	High-----------	High-----------	Low.
75----------------------- Bluffton	>60	---	---	---	High-----------	High-----------	Moderate.
109---------------------- Cordova	>60	---	---	---	High-----------	High-----------	Low.
114---------------------- Glencoe	>60	---	---	---	High-----------	High-----------	Low.
119B--------------------- Pomroy	>60	---	---	---	Low------------	Moderate--------	Low.
125---------------------- Beltrami	>60	---	---	---	High-----------	Moderate--------	Low.
129---------------------- Cylinder	>60	---	---	---	High-----------	Moderate--------	Low.
133B--------------------- Dalbo	>60	---	---	---	High-----------	High-----------	Moderate.
142---------------------- Nokay	>60	---	---	---	High-----------	Moderate--------	High.
144B, 144C, 144E--------- Flak	>60	---	---	---	Moderate--------	Low------------	Moderate.
155B--------------------- Chetek	>60	---	---	---	Low------------	Low------------	High.
156A, 156B--------------- Fairhaven	>60	---	---	---	Moderate--------	Low------------	Moderate.
159B--------------------- Anoka	>60	---	---	---	Moderate--------	Low------------	Moderate.

TABLE 17.--SOIL FEATURES--Continued

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
163B Brainerd	>60	---	---	---	Moderate	Moderate	Moderate.
179B Langola	>60	---	---	---	Low	Low	Moderate.
180A, 180B Gonvick	>60	---	---	---	High	Moderate	Low.
181 Litchfield	>60	---	---	---	Moderate	Low	Low.
183 Dassel	>60	---	---	---	High	High	Low.
200B, 200C Holdingford	>60	---	---	---	Moderate	Low	Moderate.
204B, 204C, 204E Cushing	>60	---	---	---	Moderate	Moderate	Moderate.
207B, 207C, 207E Nymore	>60	---	---	---	Low	Low	Moderate.
218 Watab	>60	---	---	---	Moderate	Moderate	Moderate.
233B Growton	>60	---	---	---	High	Low	Moderate.
236 Vallers	>60	---	---	---	High	High	Low.
255 Mayer	>60	---	---	---	High	High	Low.
260 Duelm	>60	---	---	---	Moderate	Low	Moderate.
261 Isan	>60	---	---	---	Moderate	High	Moderate.
281 Darfur	>60	---	---	---	High	High	Low.
292B Alstad	>60	---	---	---	High	Moderate	Moderate.
318 Mayer	>60	---	---	---	High	High	Low.
325 Prebish	>60	---	---	---	High	High	Low.
327A, 327B Dickman	>60	---	---	---	Low	Low	Moderate.
392, 399 Biscay	>60	---	---	---	High	Moderate	Low.
406B, 406C, 406E Dorset	>60	---	---	---	Low	Low	Moderate.
413 Osakis	>60	---	---	---	Moderate	Low	Low.
414 Hamel	>60	---	---	---	High	High	Low.

TABLE 17.--SOIL FEATURES--Continued

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
421B, 421C------------- Ves	>60	---	---	---	Moderate-------	Moderate-------	Low.
446A, 446B------------- Normania	>60	---	---	---	High-----------	Moderate-------	Low.
453B, 453C------------- DeMontreville	>60	---	---	---	Low------------	Low------------	Moderate.
454B, 454C, 454E, 454F-- Mahtomedi	>60	---	---	---	Low------------	Low------------	High.
459-------------------- Corunna	>60	---	---	---	High-----------	High-----------	Low.
461B, 461C------------- Koronis	>60	---	---	---	Moderate-------	Low------------	Moderate.
465-------------------- Kalmarville	>60	---	---	---	High-----------	Moderate-------	Low.
511-------------------- Marcellon	>60	---	---	---	High-----------	High-----------	Moderate.
525-------------------- Muskego	>60	---	---	35-45	High-----------	Moderate-------	Moderate.
540-------------------- Seelyeville	>60	---	---	50-55	High-----------	High-----------	Moderate.
541-------------------- Rifle	>60	---	---	---	High-----------	High-----------	Low.
543-------------------- Markey	>60	---	---	25-30	High-----------	High-----------	Low.
544-------------------- Cathro	>60	---	---	19-22	High-----------	High-----------	Low.
565-------------------- Eckvoll	>60	---	---	---	High-----------	Moderate-------	Low.
566-------------------- Regal	>60	---	---	---	Moderate-------	High-----------	Low.
571-------------------- Coriff	>60	---	---	---	High-----------	High-----------	Low.
572-------------------- Lowlein	>60	---	---	---	Moderate-------	Moderate-------	Low.
582-------------------- Roliss	>60	---	---	---	High-----------	High-----------	Low.
591B------------------- Doland	>60	---	---	---	Moderate-------	Low------------	Low.
597-------------------- Tara	>60	---	---	---	High-----------	Moderate-------	Low.
611C, 611D------------- Hawick	>60	---	---	---	Low------------	Low------------	Low.
639A, 639B------------- Ridgeport	>60	---	---	---	Low------------	Low------------	Low.
804D*: Koronis----------------	>60	---	---	---	Moderate-------	Low------------	Moderate.

See footnote at end of table.

TABLE 17.--SOIL FEATURES--Continued

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
804D*:							
Estherville	>60	---	---	---	Low	Low	Low.
807D*:							
Koronis	>60	---	---	---	Moderate	Low	Moderate.
Sunburg	>60	---	---	---	Moderate	Low	Low.
848*:							
Urban land.							
Osakis	>60	---	---	---	Moderate	Low	Low.
850*:							
Urban land.							
Dassel	>60	---	---	---	High	High	Low.
865B*:							
Urban land.							
Hubbard	>60	---	---	---	Low	Low	Low.
873*:							
Prebish	>60	---	---	---	High	High	Low.
Nokay	>60	---	---	---	High	Moderate	High.
875B*:							
Estherville	>60	---	---	---	Low	Low	Low.
Hawick	>60	---	---	---	Low	Low	Low.
954C*, 954D*:							
Ves	>60	---	---	---	Moderate	Moderate	Low.
Storden	>60	---	---	---	Moderate	Low	Low.
999B*, 999C*, 999D*:							
Ves	>60	---	---	---	Moderate	Moderate	Low.
Estherville	>60	---	---	---	Low	Low	Low.
1013*.							
Pits							
1015.							
Psamments							
1016.							
Udorthents							
1018.							
Udifluvents							
1029*.							
Pits							
1055*:							
Histosols.							
Aquolls.							
1064*:							
Rock outcrop.							
Lithic Eutrochrepts.							

See footnote at end of table.

TABLE 17.--SOIL FEATURES--Continued

Soil name and map symbol	Bedrock		Subsidence		Potential frost action	Risk of corrosion	
	Depth	Hardness	Initial	Total		Uncoated steel	Concrete
	In		In	In			
1805 Blue Earth Variant	>60	---	---	---	High	High	Low.
1825C Seelyeville	>60	---	4-12	50-55	High	High	Moderate.
1828 Glencoe	>60	---	---	---	High	High	Low.
1842F*:							
Cushing	>60	---	---	---	Moderate	Moderate	Moderate.
Flak	>60	---	---	---	Moderate	Low	Moderate.
1843C*, 1843E*:							
Cushing	>60	---	---	---	Moderate	Moderate	Moderate.
DeMontreville	>60	---	---	---	Low	Low	Moderate.
1879 Seelyeville	>60	---	---	50-55	High	High	Moderate.
1880 Martisco	>60	---	---	---	High	High	Low.
1892 Prebish	>60	---	---	---	High	High	Low.
1902B Jewett	>60	---	---	---	Moderate	Moderate	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Alstad	Fine-loamy, mixed Aquic Eutroboralfs
*Anoka	Coarse-loamy, mixed Eutric Glossoboralfs
Aquolls	Loamy, mixed, frigid Haplaquolls
Becker	Coarse-loamy, mixed, mesic Typic Hapludolls
Beltrami	Fine-loamy, mixed Aquic Eutroboralfs
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Blue Earth Variant	Fine-silty over sandy or sandy-skeletal, mixed, nonacid, mesic Mollic Fluvaquents
Bluffton	Fine-loamy, mixed, frigid Typic Haplaquolls
Brainerd	Coarse-loamy, mixed, frigid Aquic Fragiochrepts
Cathro	Loamy, mixed, euic Terric Borosaprists
Chetek	Coarse-loamy, mixed Eutric Glossoboralfs
Cordova	Fine-loamy, mixed, mesic Typic Argiaquolls
Coriff	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
Corunna	Coarse-loamy, mixed, mesic Typic Haplaquolls
Cushing	Fine-loamy, mixed Glossic Eutroboralfs
Cylinder	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Dakota	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Argiudolls
*Dalbo	Fine, mixed Aquic Eutroboralfs
Darfur	Coarse-loamy, mixed, mesic Typic Haplaquolls
Dassel	Coarse-loamy, mixed, mesic Typic Haplaquolls
DeMontreville	Loamy, mixed Arenic Eutroboralfs
Dickman	Sandy, mixed, mesic Typic Hapludolls
Doland	Fine-loamy, mixed Udic Haploborolls
Dorset	Coarse-loamy, mixed Boralfic Udic Argiborolls
Duelm	Sandy, mixed Aquic Haploborolls
Eckvoll	Fine-loamy, mixed Aquic Eutroboralfs
Estherville	Sandy, mixed, mesic Typic Hapludolls
Fairhaven	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Fedji	Sandy over loamy, mixed, mesic Typic Hapludolls
Flak	Coarse-loamy, mixed, frigid Typic Fragiochrepts
Flom	Fine-loamy, mixed, frigid Typic Haplaquolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Gonvick	Fine-loamy, mixed Aquic Argiborolls
Growton	Coarse-loamy, mixed Aquic Eutroboralfs
Hamel	Fine-loamy, mixed, mesic Typic Argiaquolls
Hawick	Sandy, mixed, mesic Entic Hapludolls
Histosols	Borosaprists
Holdingford	Coarse-loamy, mixed Mollic Eutroboralfs
Hubbard	Sandy, mixed Udorthentic Haploborolls
Isan	Sandy, mixed, frigid Typic Haplaquolls
*Jewett	Fine-loamy, mixed Eutric Glossoboralfs
*Kalmarville	Coarse-loamy, mixed, nonacid, mesic Mollic Fluvaquents
Koronis	Fine-loamy, mixed, mesic Mollic Hapludalfs
Langola	Sandy, mixed Udorthentic Haploborolls
*Litchfield	Sandy, mixed, mesic Aquic Hapludolls
Lithic Eutrochrepts	Loamy, mixed, frigid Lithic Eutrochrepts
Lowlein	Coarse-loamy, mixed, mesic Typic Hapludolls
Mahtomedi	Mixed, frigid Typic Udipsamments
Marcellon	Fine-loamy, mixed, mesic Aquic Argiudolls
Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
*Martisco	Fine-silty, carbonatic, mesic Histic Humaquepts
*Mayer	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Muskego	Coprogenous, euic, mesic Limnic Medisaprists
Nebish	Fine-loamy, mixed Typic Eutroboralfs
Nokay	Coarse-loamy, mixed, frigid Aeric Fragiaqualfs
Normania	Fine-loamy, mixed, mesic Aquic Haplustolls
Nymore	Mixed, frigid Typic Udipsamments
Osakis	Sandy, mixed Aquic Haploborolls
Pomroy	Sandy, mixed, frigid Typic Fragiochrepts
Prebish	Coarse-loamy, mixed, frigid Typic Haplaquolls
Psamments	Mixed, frigid Udipsamments
Regal	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Ridgeport	Coarse-loamy, mixed, mesic Typic Hapludolls
Rifle	Euic Typic Borohemists
Roliss	Fine-loamy, mixed (calcareous), frigid Typic Haplaquolls
Seelyeville	Euic Typic Borosaprists
Shooker	Fine-loamy, mixed, frigid Typic Ochraqualfs

See footnote at end of table.

TABLE 18.--CLASSIFICATION OF THE SOILS--Continued

Soil name	Family or higher taxonomic class
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Sunburg	Coarse-loamy, mixed (calcareous), mesic Typic Udorthents
Tara	Fine-silty, mixed Pachic Udic Haploborolls
Udifluvents	Sandy and loamy, mixed, nonacid, frigid Udifluvents
Udorthents	Loamy, mixed, nonacid, frigid Udorthents
Vallers	Fine-loamy, frigid Typic Calciaquolls
Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Watab	Coarse-loamy, mixed, frigid Aquic Fragiochrepts
Waukon	Fine-loamy, mixed Mollic Eutroboralfs

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1985 O - 444-982 QL 3

Accessibility Statement

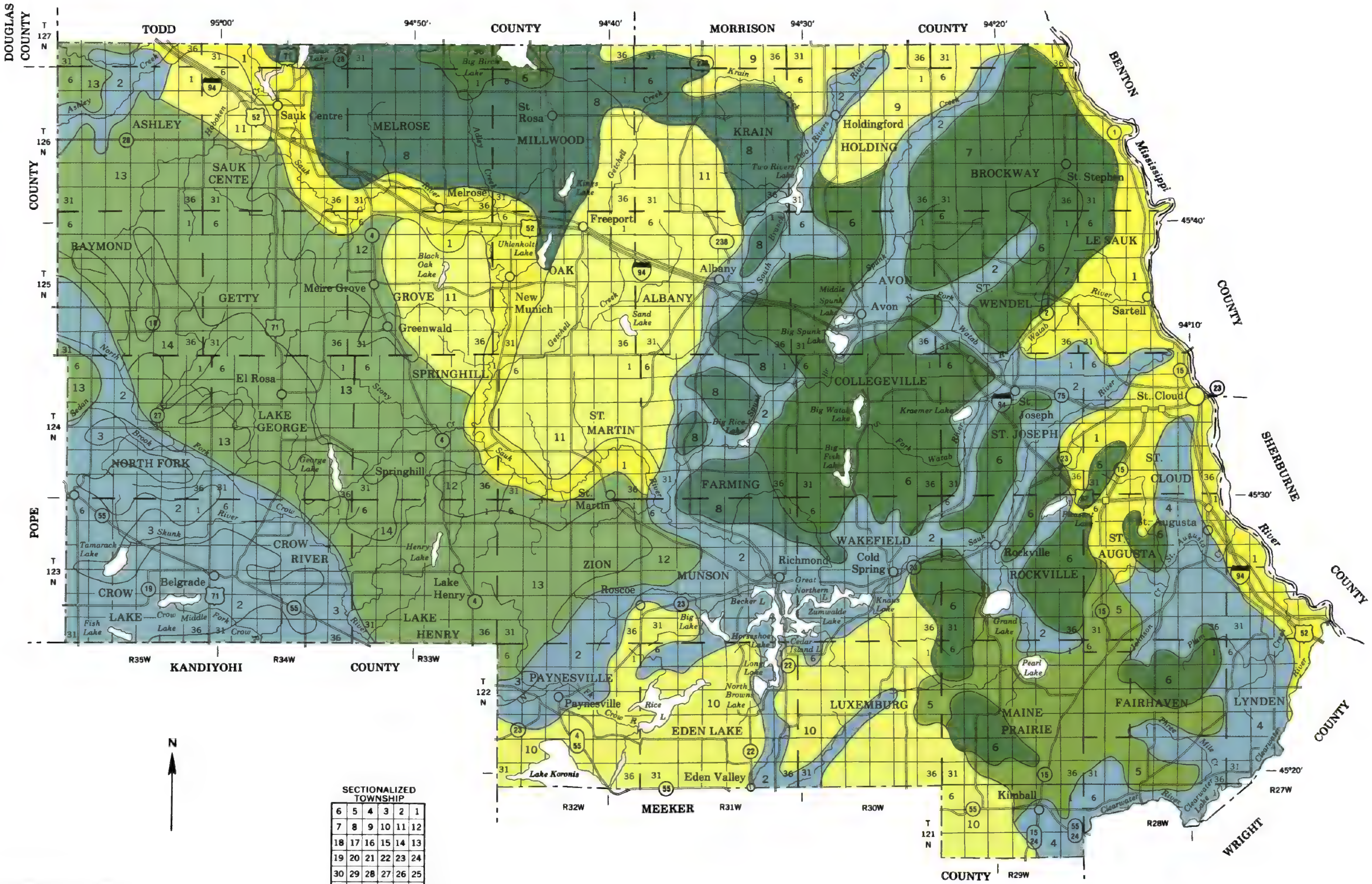
This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457–3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all of its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex (including gender identity and expression), marital status, familial status, parental status, religion, sexual orientation, political beliefs, genetic information, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

To file a complaint of discrimination, write to:

USDA
Assistant Secretary for Civil Rights
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, S.W., Stop 9410
Washington, DC 20250-9410

Or call toll-free at (866) 632-9992 (English) or (800) 877-8339 (TDD) or (866) 377-8642 (English Federal-relay) or (800) 845-6136 (Spanish Federal-relay). USDA is an equal opportunity provider and employer.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

LEGEND*

NEARLY LEVEL TO SLOPING SOILS THAT FORMED IN A SANDY OR LOAMY MANTLE AND THE UNDERLYING NONCALCAREOUS. SANDY OUTWASH UNDER SAVANNA VEGETATION

1 — Hubbard-Dickman association: Nearly level to sloping, excessively drained and well drained, coarse textured and moderately coarse textured soils on outwash plains and stream terraces

NEARLY LEVEL TO VERY STEEP SOILS THAT FORMED IN A LOAMY OR SANDY MANTLE AND THE UNDERLYING SANDY OUTWASH UNDER PRAIRIE VEGETATION

2 — Estherville-Hawick association: Nearly level to very steep, somewhat excessively drained and excessively drained, moderately coarse textured and coarse textured soils on outwash plains and stream terraces

3 — Regal-Osakis association: Nearly level, poorly drained and moderately well drained, medium textured soils on outwash plains and stream terraces

4 — Dorset-Nymore association: Undulating to steep, well drained and excessively drained, moderately coarse textured and coarse textured soils on outwash plains and stream terraces

NEARLY LEVEL TO STEEP SOILS THAT FORMED IN A LOAMY MANTLE AND THE UNDERLYING SANDY OUTWASH UNDER PRAIRIE VEGETATION

5 — Fairhaven-Estherville association: Nearly level to steep, well drained and somewhat excessively drained, medium textured and moderately coarse textured soils on outwash plains, valley trains, and stream terraces

NEARLY LEVEL TO VERY STEEP SOILS THAT FORMED IN LOAMY, NONCALCAREOUS GLACIAL TILL OR SANDY OUTWASH UNDER FOREST VEGETATION

Cushing-Mahtomedi association: Undulating to very steep, well drained and excessively drained, moderately coarse textured and coarse textured soils on uplands

Brainerd-Flak association: Nearly level to very steep, moderately well drained and well drained, moderately coarse textured soils on uplands

NEARLY LEVEL TO VERY STEEP SOILS THAT FORMED IN LOAMY, CALCAREOUS GLACIAL TILL UNDER FOREST VEGETATION

Nebish-Beltrami association: Nearly level to very steep, well drained to somewhat poorly drained, moderately coarse textured and medium textured soils on uplands

NEARLY LEVEL TO STEEP SOILS THAT FORMED IN LOAMY, CALCAREOUS GLACIAL TILL UNDER SAVANNA VEGETATION

9 — Holdingford-Growton association: Nearly level to sloping, well drained and moderately well drained, moderately coarse textured soils on uplands

10 — Koronis-Marcellon association: Nearly level to steep, well drained and somewhat poorly drained, medium textured soils on uplands

11 — Gonvick-Waukon association: Nearly level to moderately steep, somewhat poorly drained to well drained, medium textured soils on uplands

NEARLY LEVEL TO STEEP SOILS THAT FORMED IN LOAMY, CALCAREOUS GLACIAL TILL UNDER PRAIRIE VEGETATION

Ves-Normania association: Nearly level to steep, well drained and moderately well drained, medium textured soils on uplands

13 — Normania-Flom association: Nearly level to undulating, moderately well drained and poorly drained, medium textured soils on uplands

Roliss-Flom association: Nearly level, poorly drained, medium textured soils on uplands

*Unless otherwise indicated, terms describing texture refer to the surface layer of the major soils in each association.

Compiled 1984

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

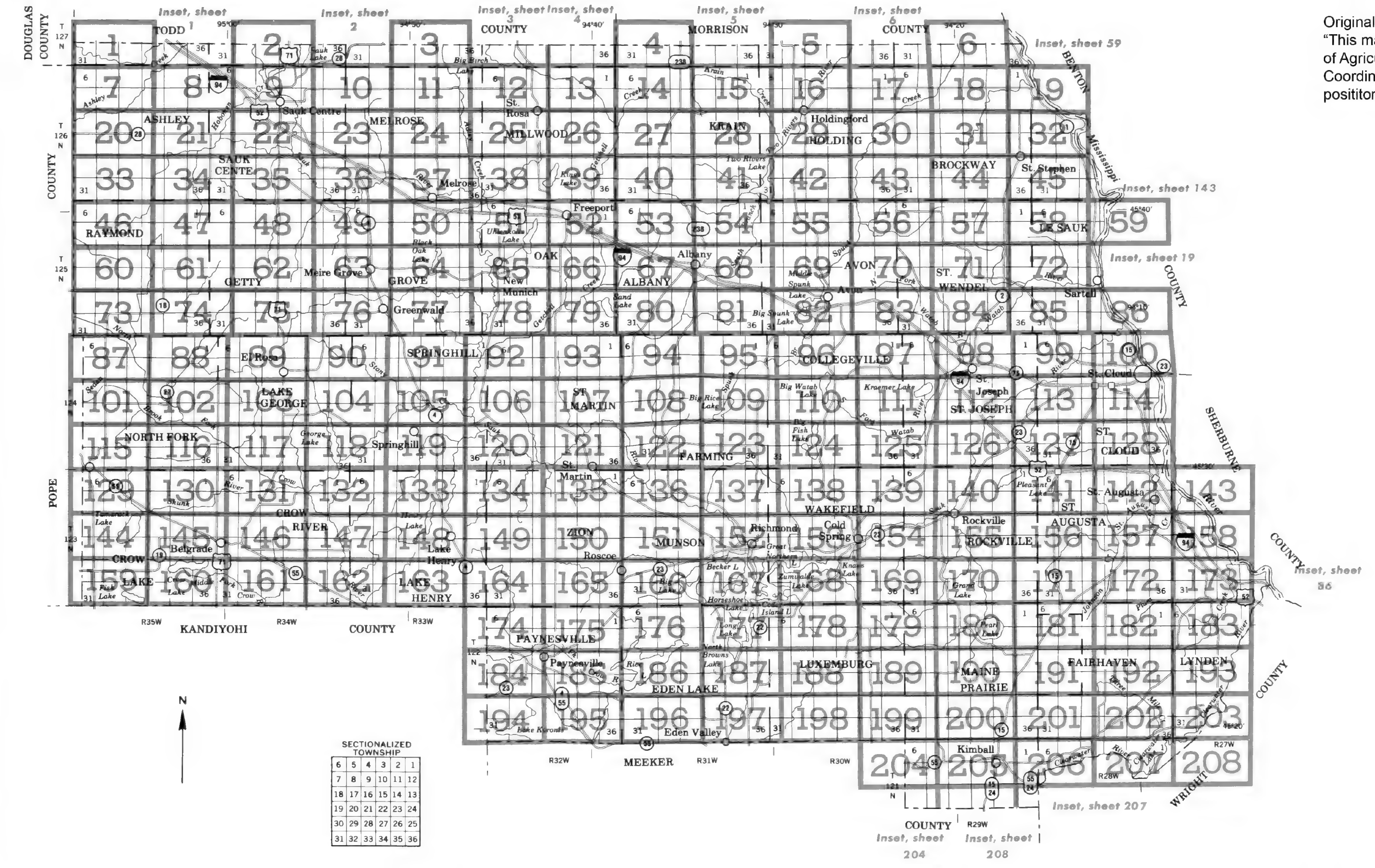
GENERAL SOIL MAP
STEARNS COUNTY, MINNESOTA

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

Original text from each map sheet:
“This map is compiled on 1975 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately posititoned.”



6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS
STEARNS COUNTY, MINNESOTA

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial number represents the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils, soils named for higher categories of "Soil Taxonomy," or miscellaneous areas.

SYMBOL	NAME
5A	Dakota loam, 0 to 2 percent slopes
5B	Dakota loam, 2 to 6 percent slopes
7A	Hubbard loamy sand, 0 to 2 percent slopes
7B	Hubbard loamy sand, 2 to 6 percent slopes
7C	Hubbard loamy sand, 6 to 12 percent slopes
25	Becker fine sandy loam
32B	Nebish sandy loam, 2 to 8 percent slopes
32C	Nebish sandy loam, 8 to 15 percent slopes
32E	Nebish sandy loam, 15 to 25 percent slopes
32F	Nebish sandy loam, 25 to 40 percent slopes
35	Blue Earth mucky silt loam
36	Flom loam
38B	Waukon loam, 2 to 6 percent slopes
38C	Waukon loam, 6 to 12 percent slopes
38D	Waukon loam, 12 to 18 percent slopes
41A	Estherville sandy loam, 0 to 2 percent slopes
41B	Estherville sandy loam, 2 to 6 percent slopes
41C	Estherville sandy loam, 6 to 12 percent slopes
69B	Fedji loamy sand, 2 to 6 percent slopes
72	Shooker loam
75	Bluffton loam
109	Cordova loam
114	Glencoe loam
119B	Pomroy fine sand, 1 to 8 percent slopes
125	Beltrami loam
129	Cylinder loam
133B	Dalbo loam, 2 to 8 percent slopes
142	Nokay fine sandy loam
144B	Flak sandy loam, 4 to 8 percent slopes
144C	Flak sandy loam, 8 to 15 percent slopes
144E	Flak sandy loam, 15 to 25 percent slopes
155B	Chetek sandy loam, 1 to 6 percent slopes
156A	Fairhaven loam, 0 to 2 percent slopes
156B	Fairhaven loam, 2 to 6 percent slopes
159B	Anoka loamy sand, 2 to 8 percent slopes
163B	Brainerd fine sandy loam, 1 to 4 percent slopes
179B	Langola loamy sand, 1 to 4 percent slopes
180A	Gonvick loam, 1 to 2 percent slopes
180B	Gonvick loam, 2 to 4 percent slopes
181	Litchfield loamy sand
183	Dassel sandy loam
200B	Holdingford sandy loam, 4 to 8 percent slopes
200C	Holdingford sandy loam, 8 to 15 percent slopes
204B	Cushing sandy loam, 2 to 8 percent slopes
204C	Cushing sandy loam, 8 to 15 percent slopes
204E	Cushing sandy loam, 15 to 25 percent slopes
207B	Nymore loamy sand, 2 to 8 percent slopes
207C	Nymore loamy sand, 8 to 15 percent slopes
207E	Nymore loamy sand, 15 to 25 percent slopes
218	Watab loamy fine sand
233B	Growton sandy loam, 1 to 4 percent slopes
236	Vallers loam
255	Mayer loam
260	Duelm loamy sand
261	Isan loamy sand
281	Darfur coarse sandy loam
292B	Alstad sandy loam, 1 to 4 percent slopes
318	Mayer loam, depressional
325	Prebish sandy loam, depressional
327A	Dickman sandy loam, 0 to 2 percent slopes
327B	Dickman sandy loam, 2 to 6 percent slopes
392	Biscay loam
399	Biscay loam, depressional
406B	Dorset sandy loam, 2 to 8 percent slopes
406C	Dorset sandy loam, 8 to 15 percent slopes
406E	Dorset sandy loam, 15 to 25 percent slopes

SYMBOL	NAME
413	Osakis loam
414	Hamel loam
421B	Ves loam, 2 to 6 percent slopes
421C	Ves loam, 6 to 12 percent slopes
446A	Normania loam, 1 to 3 percent slopes
446B	Normania loam, 3 to 5 percent slopes
453B	DeMontreville loamy sand, 2 to 8 percent slopes
453C	DeMontreville loamy sand, 8 to 15 percent slopes
454B	Mahtomedi loamy coarse sand, 2 to 8 percent slopes
454C	Mahtomedi loamy coarse sand, 8 to 15 percent slopes
454E	Mahtomedi loamy coarse sand, 15 to 25 percent slopes
454F	Mahtomedi loamy coarse sand, 25 to 40 percent slopes
459	Corunna loam
461B	Koronis loam, 2 to 6 percent slopes
461C	Koronis loam, 6 to 12 percent slopes
465	Kalmarville sandy loam, frequently flooded
511	Marcellon loam
525	Muskego muck
540	Seelyeville muck
541	Rifle mucky peat
543	Markey muck
544	Cathro muck
565	Eckvoll loamy sand
566	Regal loam
571	Coriff loam
572	Lowlein sandy loam
582	Roliss loam
591B	Doland silt loam, 1 to 6 percent slopes
597	Tara silt loam
611C	Hawick loamy sand, 6 to 12 percent slopes
611D	Hawick loamy sand, 12 to 40 percent slopes
639A	Ridgeport sandy loam, 0 to 2 percent slopes
639B	Ridgeport sandy loam, 2 to 6 percent slopes
804D	Koronis-Estherville complex, 12 to 25 percent slopes
807D	Koronis-Sunburg complex, 12 to 25 percent slopes
848	Urban land-Osakis complex
850	Urban land-Dassel complex
865B	Urban land-Hubbard complex, 1 to 8 percent slopes
873	Prebish-Nokay complex
875B	Estherville-Hawick complex, 2 to 6 percent slopes
954C	Ves-Storden loams, 6 to 12 percent slopes
954D	Ves-Storden loams, 12 to 18 percent slopes
999B	Ves-Estherville complex, 2 to 6 percent slopes
999C	Ves-Estherville complex, 6 to 12 percent slopes
999D	Ves-Estherville complex, 12 to 25 percent slopes
1013	Pits, quarry
1015	Psamments, sloping
1016	Udorthents, loamy
1018	Udifluvents, frequently flooded
1029	Pits, gravel
1055	Histosols and Haplaquolls, ponded
1064	Rock outcrop-Lithic Eutrocrepts complex
1805	Blue Earth Variant, mucky silt loam
1825C	Seelyeville muck, sloping
1828	Glencoe muck
1842F	Cushing and Flak sandy loams, steep
1843C	Cushing-DeMontreville complex, 8 to 15 percent slopes
1843E	Cushing-DeMontreville complex, 15 to 25 percent slopes
1879	Seelyeville muck, calcareous
1880	Martisco mucky silt loam
1892	Prebish fine sandy loam
1902B	Jewett silt loam, 2 to 8 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- County or parish
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK — 205 000 FEET

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 94
- Federal — 71
- State — 23
- County, farm or ranch — 9

RAILROAD

DAMS

- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
- Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 582; 446B

ESCARPMENTS

- Other than bedrock (points down slope)

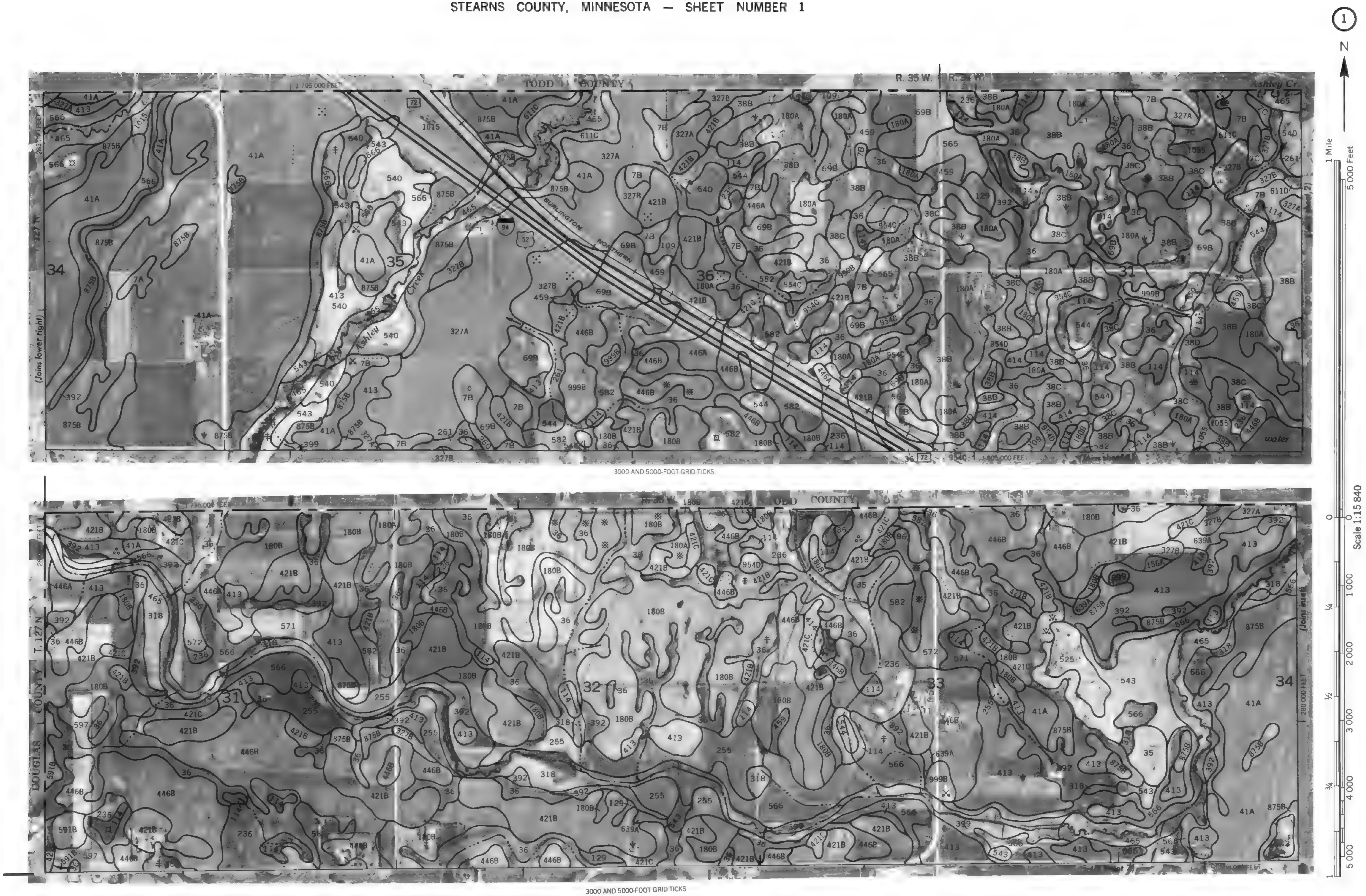
SHORT STEEP SLOPE

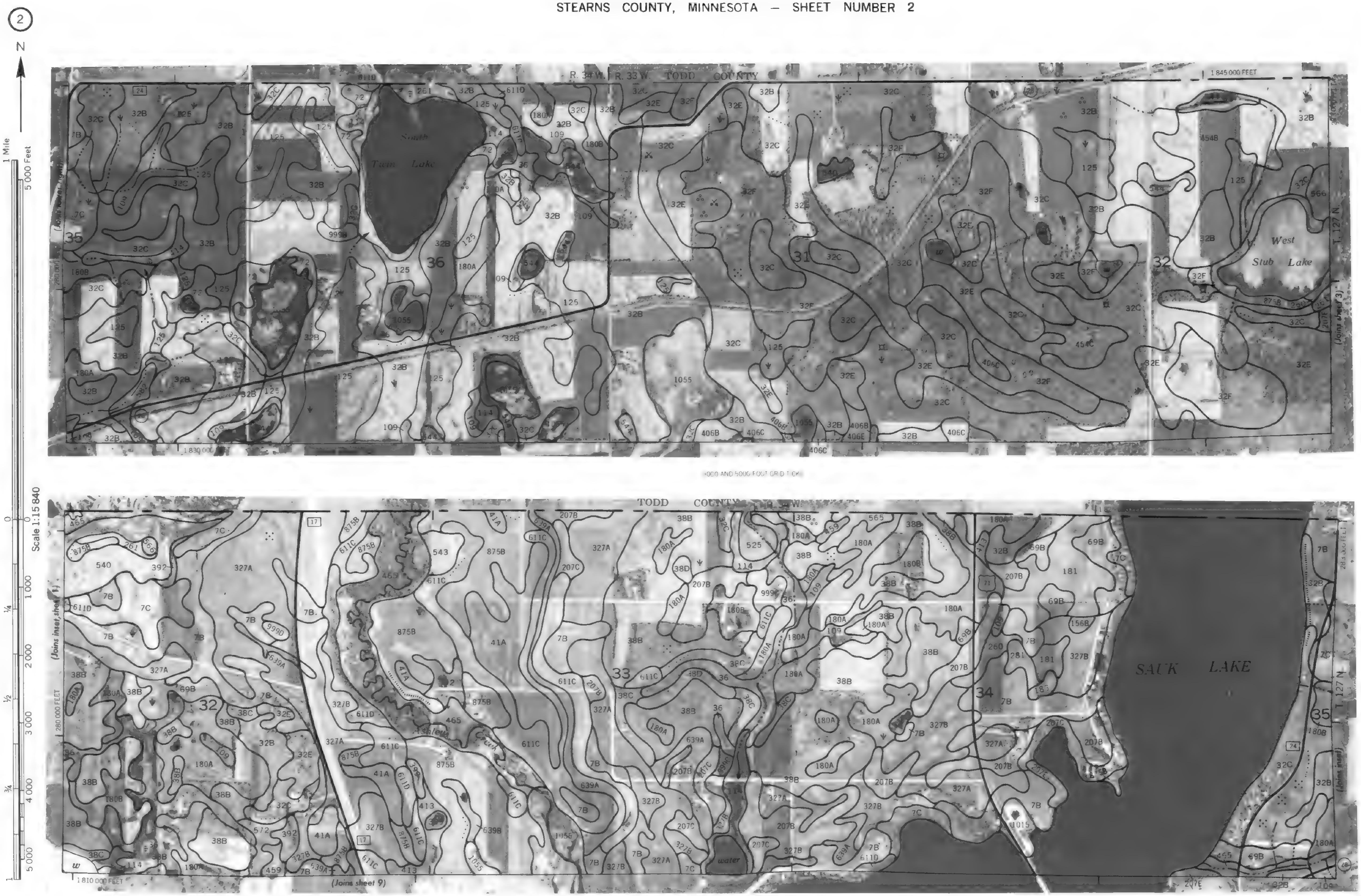
GULLY

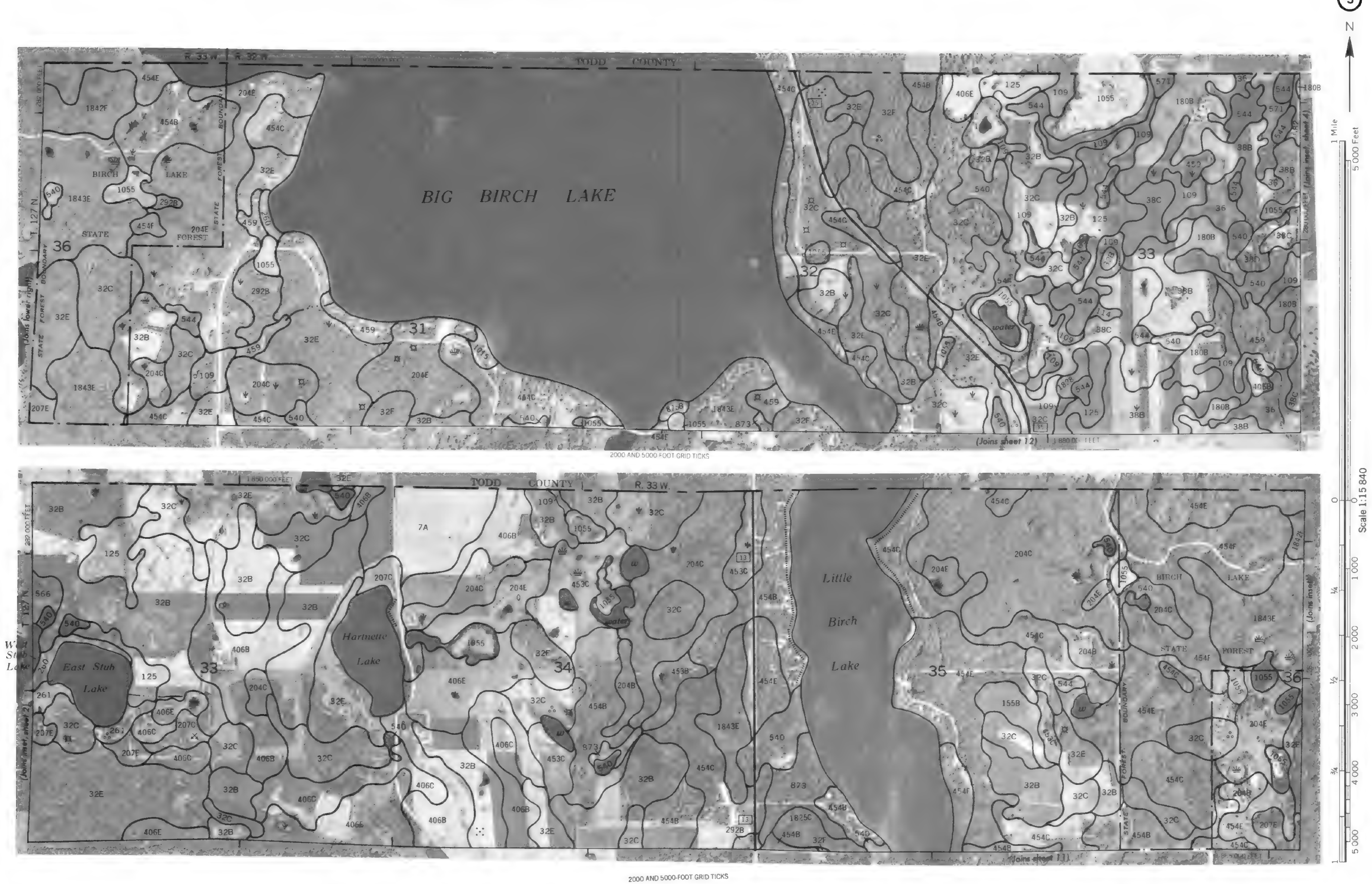
DEPRESSION OR SINK

MISCELLANEOUS

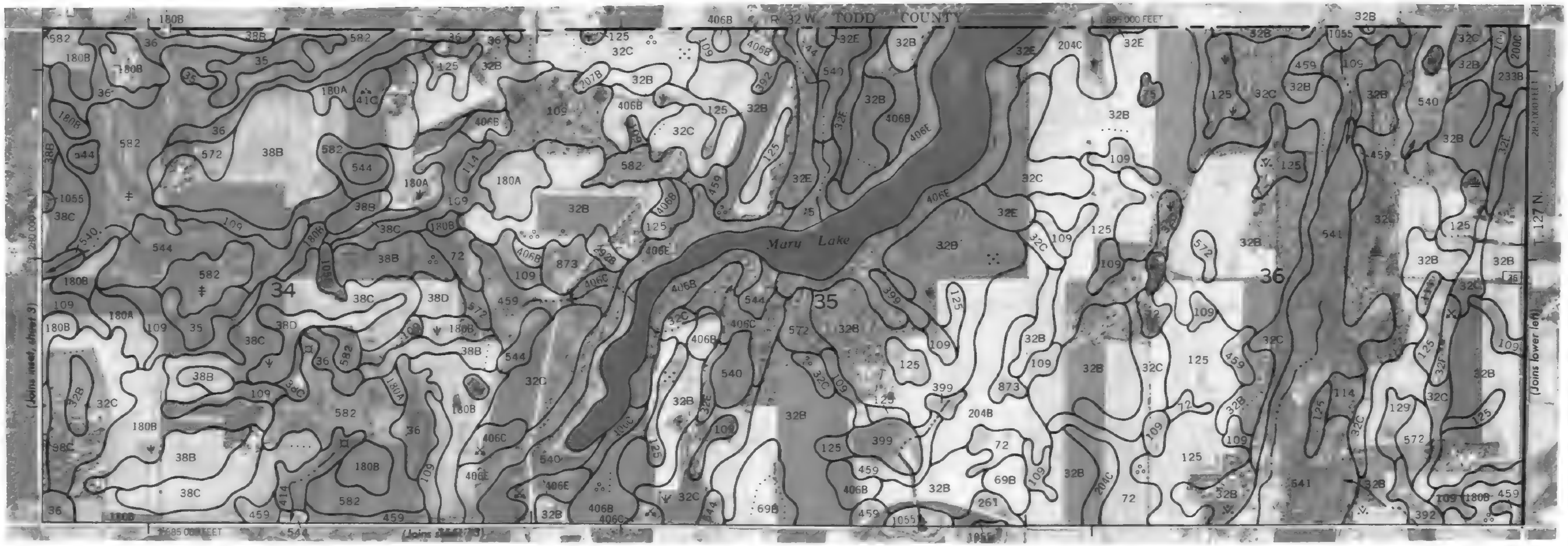
- Clay spot
- Gravelly spot
- Dumps and other similar non soil areas
- Rock outcrop (includes sandstone and shale)
- Sandy spot
- Stony spot, very stony spot
- Organic soil
- Calcareous soil
- Better drained soil in poorly drained area
- Silty spot
- Cut and fill area


1
N
TODD COUNTY
R. 35 W.
Ashley Cr.
BURLINGTON NORTHERN
Ashley Creek
T. 127 N.
(Joins lower right)
water
3000 AND 5000-FOOT GRID TICKS
TODD COUNTY
R. 35 W.
DOUGLAS COUNTY
T. 127 N.
(Joins inset)
3000 AND 5000-FOOT GRID TICKS
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000

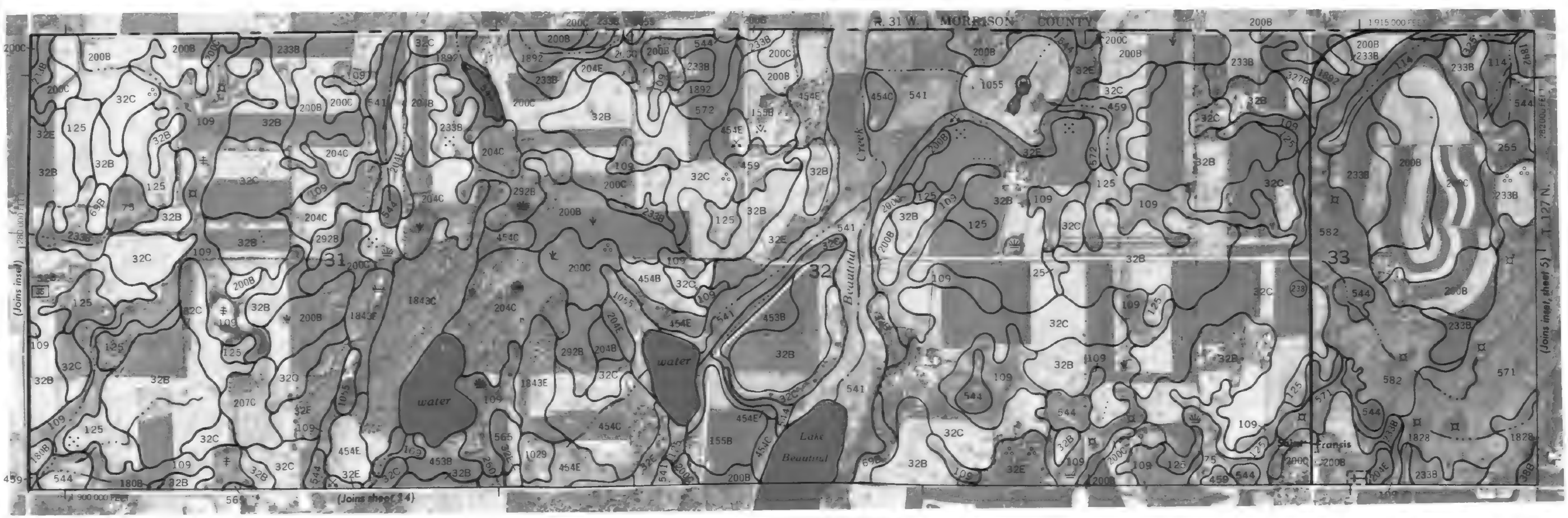

2
N
Scale 1:15 840
1 Mile
5 000 Feet
R. 34 W. | R. 33 W.
TODD COUNTY
1 845 000 FEET
South Twin Lake
West Stub Lake
T. 127 N.
(Joins sheet 3)
(Joins inset, sheet 1)
280 000 FEET
1 830 000 FEET
3000 AND 5000-FOOT GRID TICKS
TODD COUNTY
R. 34 W.
SAUK LAKE
Getchell Creek
(Joins sheet 9)
(Joins inset)
1 810 000 FEET
283 000 FEET
3000 AND 5000-FOOT GRID TICKS
35
36
31
32
33
34


3
N
TODD COUNTY
R. 33 W.
R. 32 W.
T. 127 N.
BIG BIRCH LAKE
BIRCH LAKE STATE FOREST
STATE FOREST BOUNDARY
Little Birch Lake
Hartnette Lake
East Stub Lake
West Stub Lake
water
31
32
33
34
35
36
(Joins lower right)
(Joins inset, sheet 4)
(Joins sheet 12)
(Joins inset, sheet 2)
(Joins sheet 11)
2000 AND 5000 FOOT GRID TICKS
2000 AND 5000-FOOT GRID TICKS
Scale 1:15 840
1 Mile
5 000 Feet

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 4



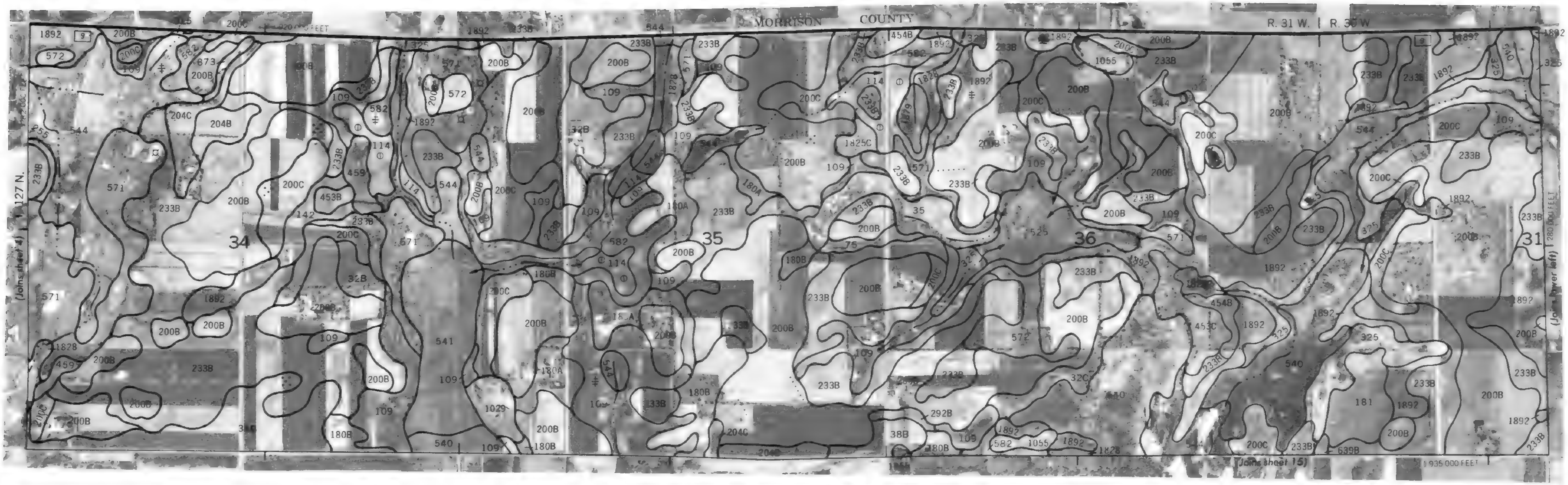
2000 AND 5000-FOOT GRID TICKS



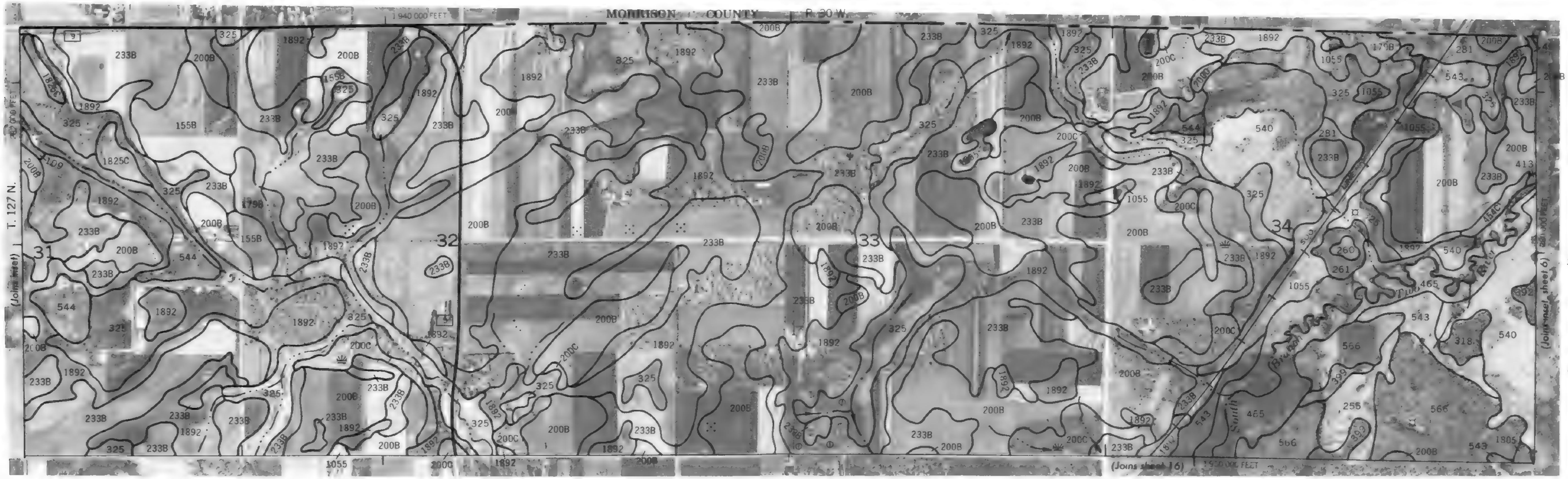
2000 AND 5000 FOOT GRID TICKS

5

N



2000 AND 5000 FOOT GRID TICKS

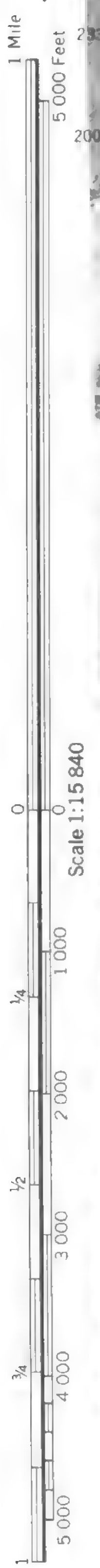


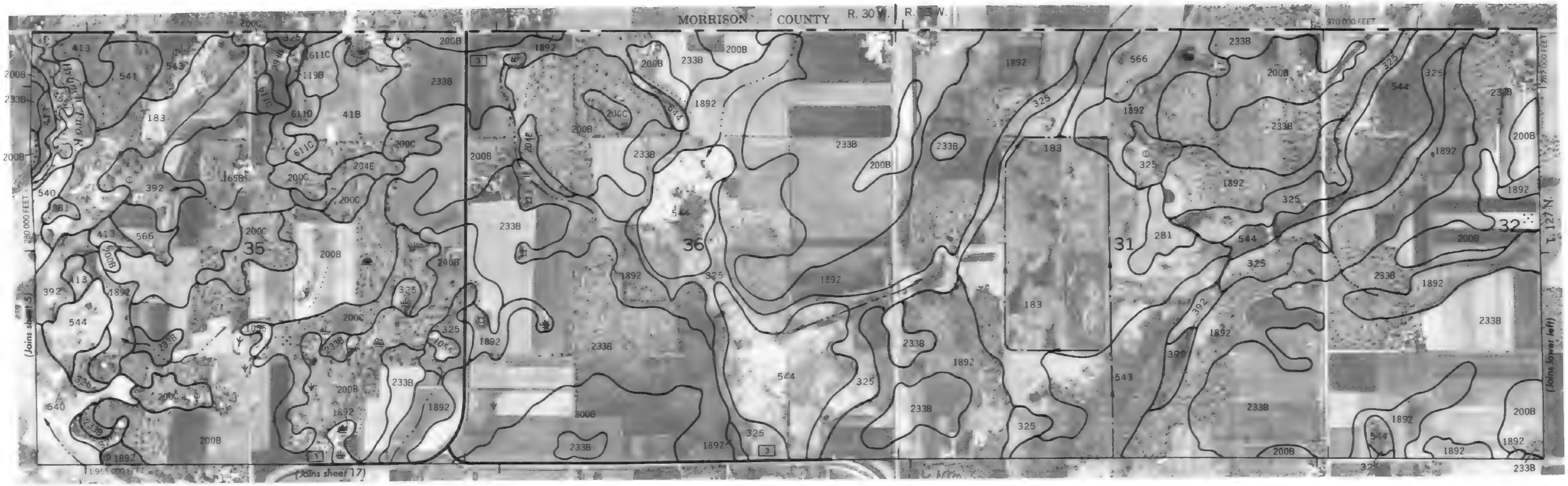
2000 AND 5000-FOOT GRID TICKS

1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2000
3 000
4 000
5 000
¼
½
¾
1

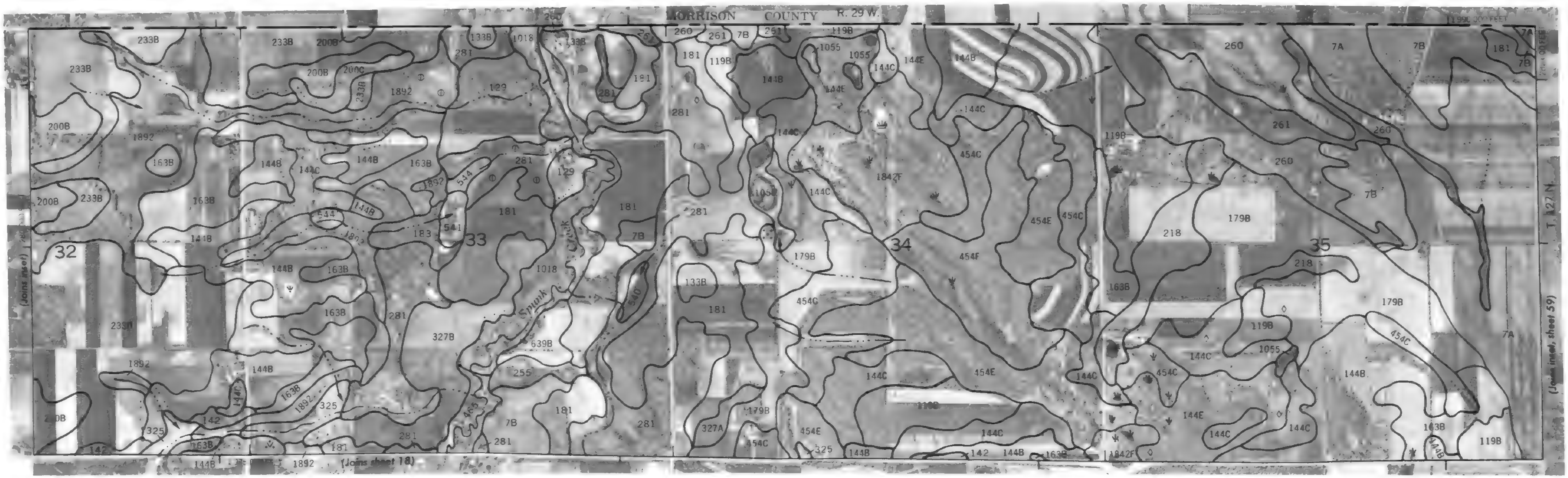
6

N

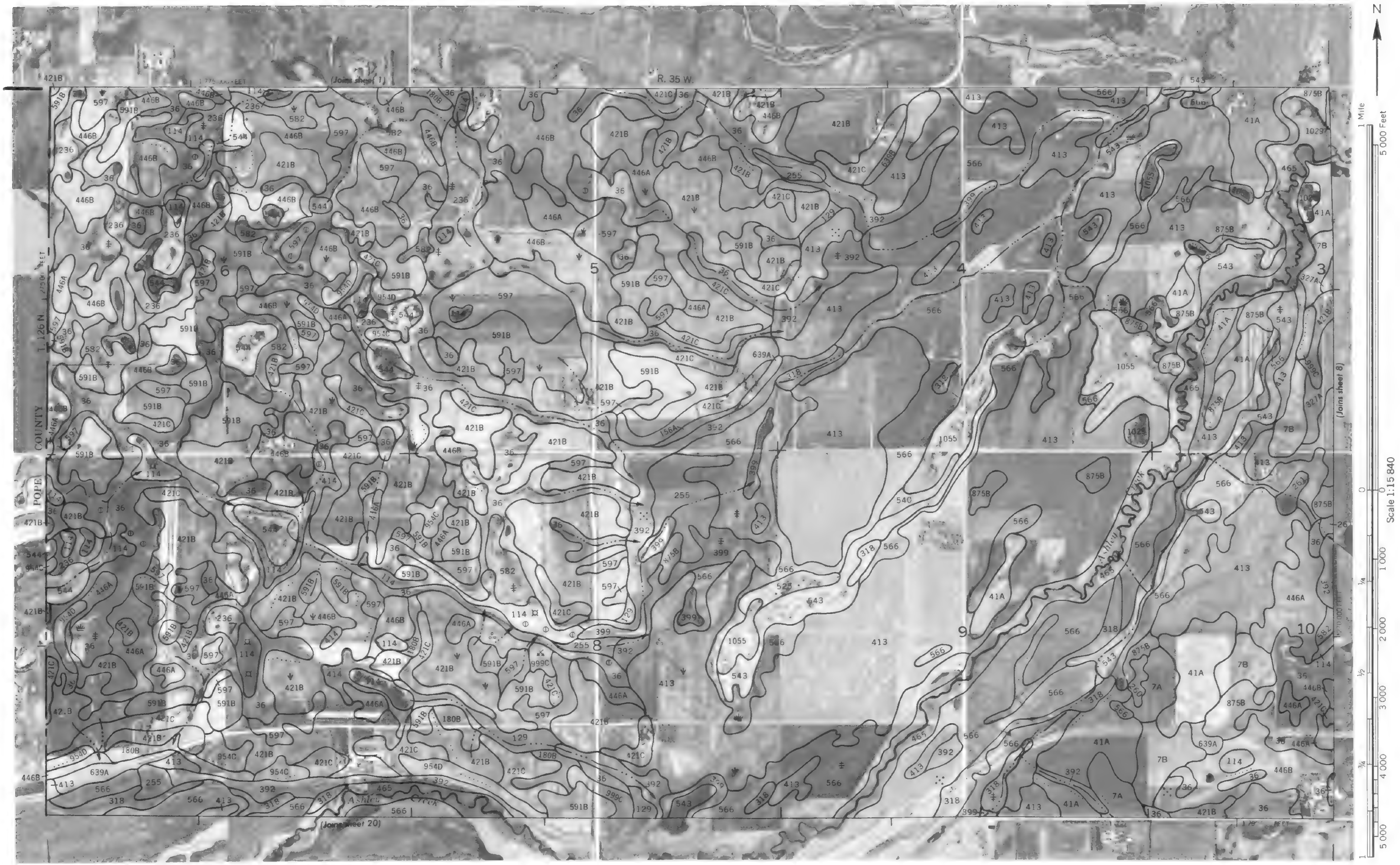




2000 AND 5000-FOOT GRID TICKS

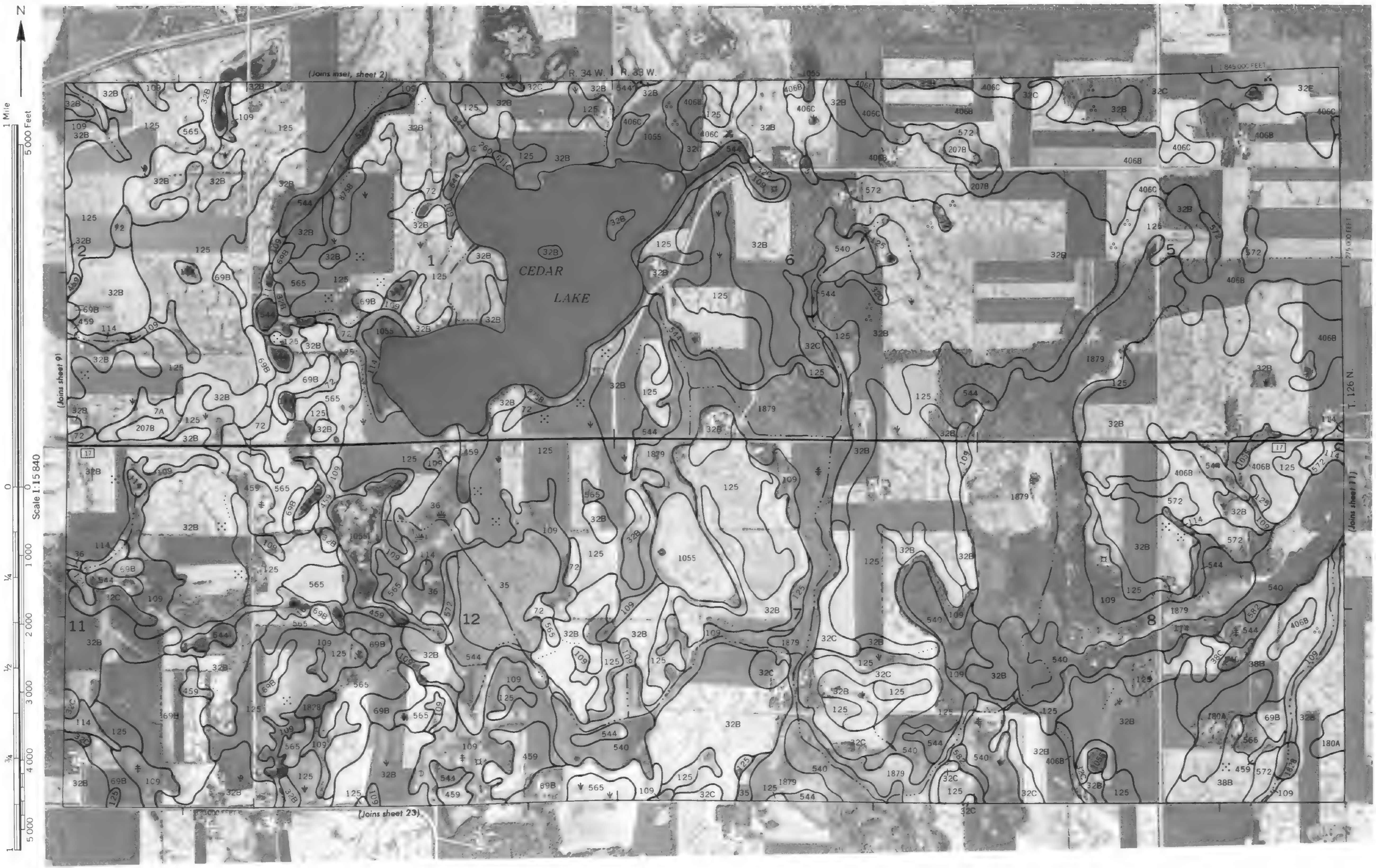


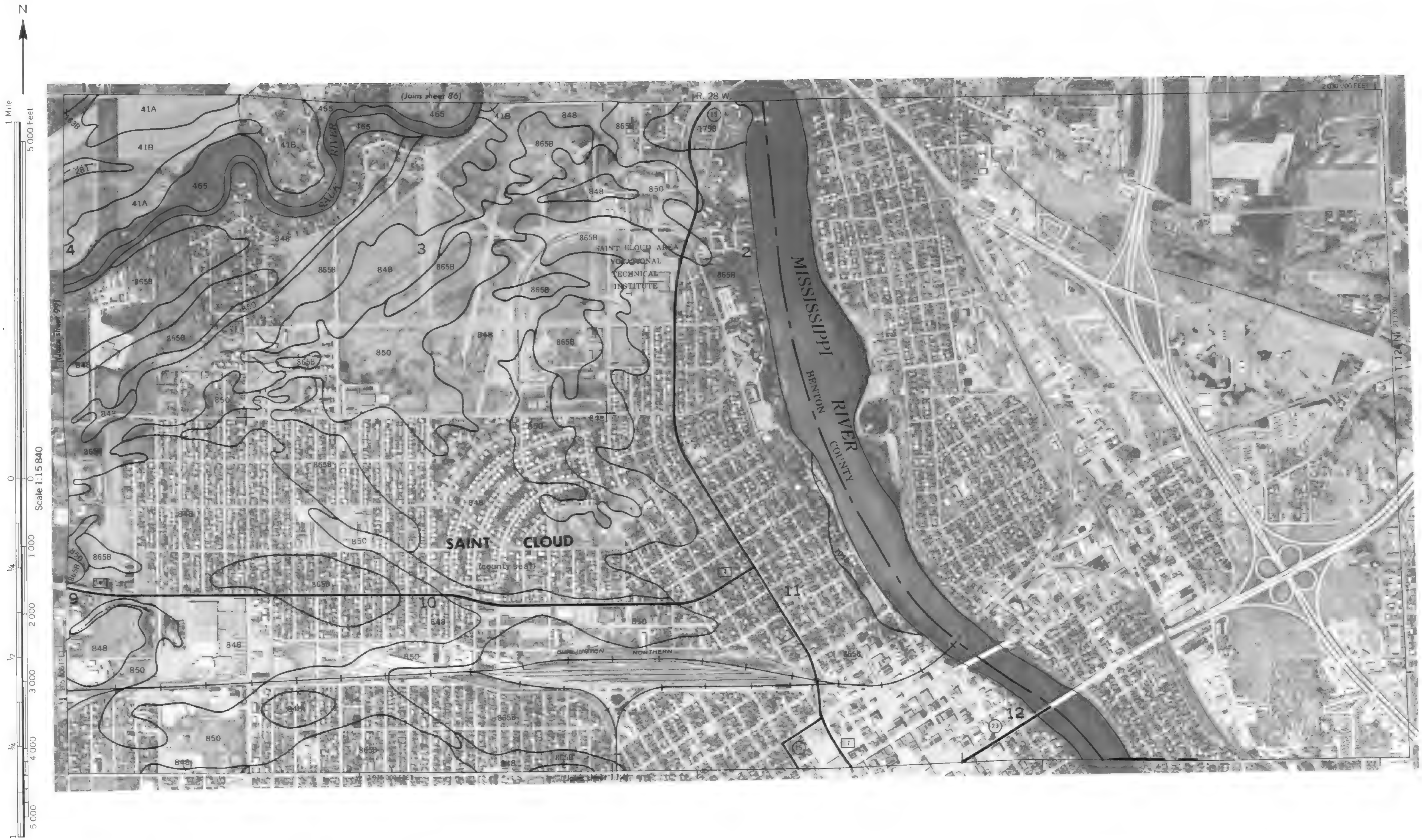
2000 AND 5000-FOOT GRID TICKS

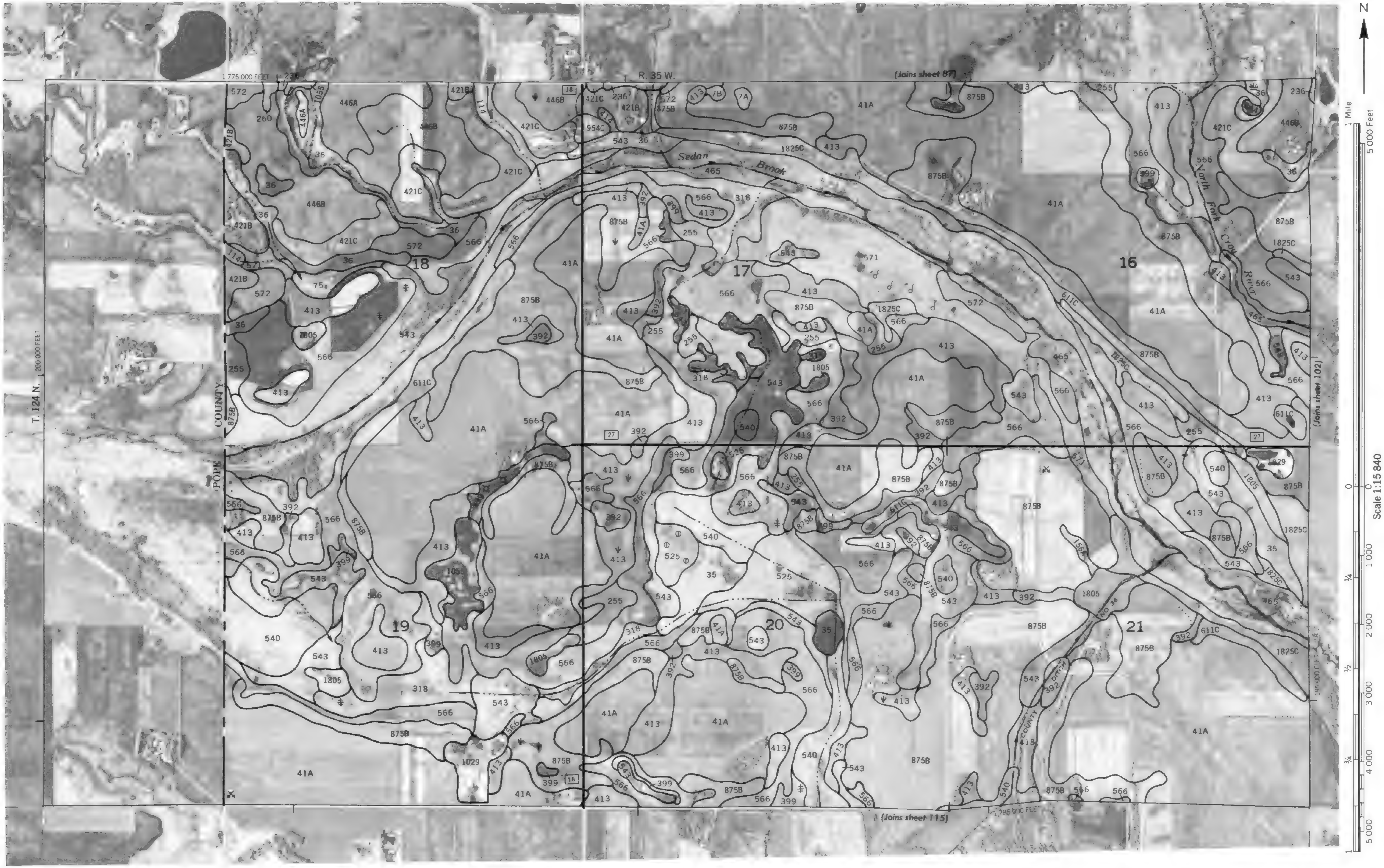

N
(Joins sheet 1)
R. 35 W.
T. 126 N.
POPE COUNTY
(Joins sheet 8)
(Joins sheet 20)
Ashley Creek
1 Mile
5 000 Feet
Scale 1:15 840

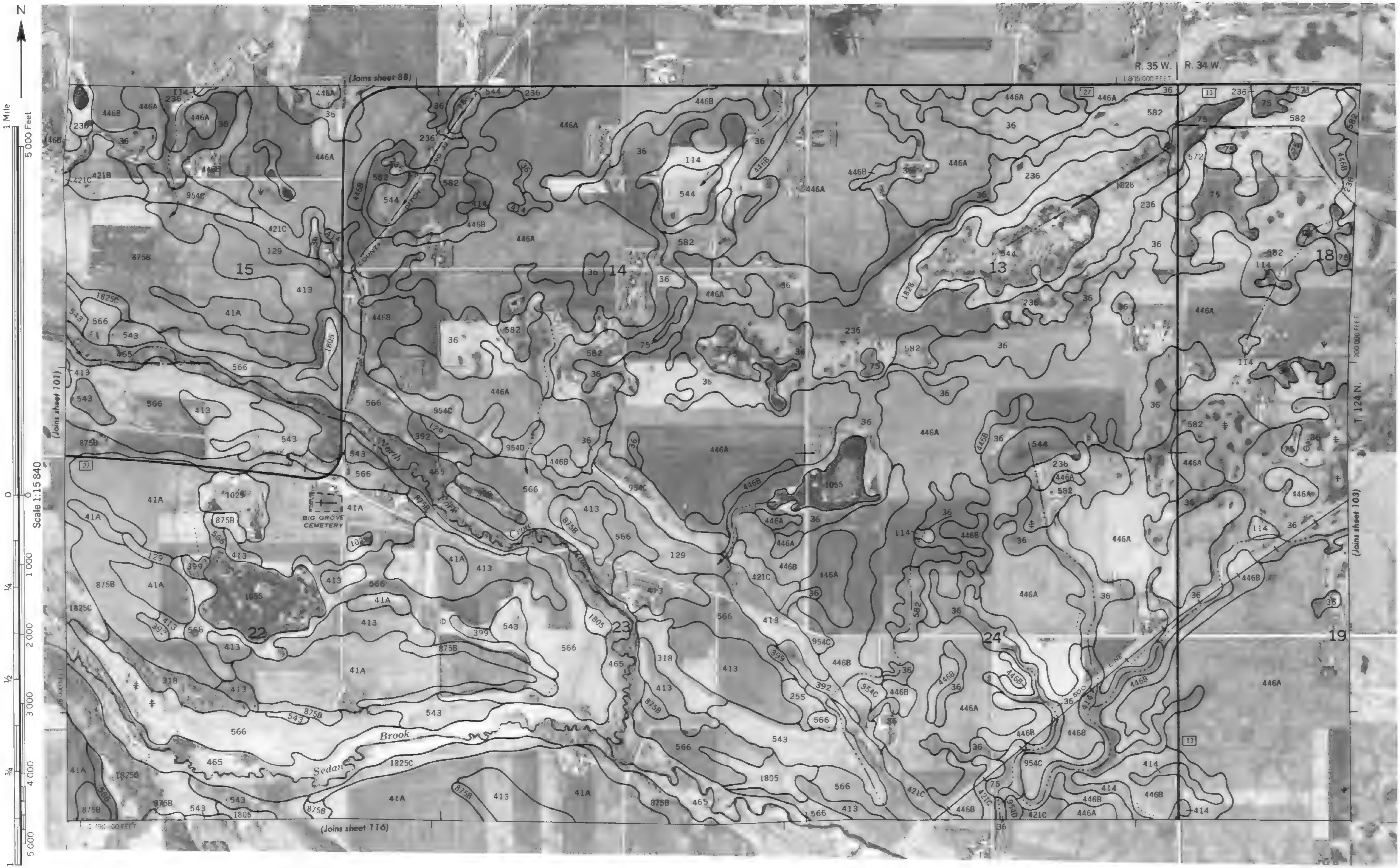

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins inset, sheet 1)
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 21)
R. 35 W.
R. 34 W.
T. 126 N.
TOWNSHIP CEMETERY
BURLINGTON NORTHERN
Hoboken Creek
water

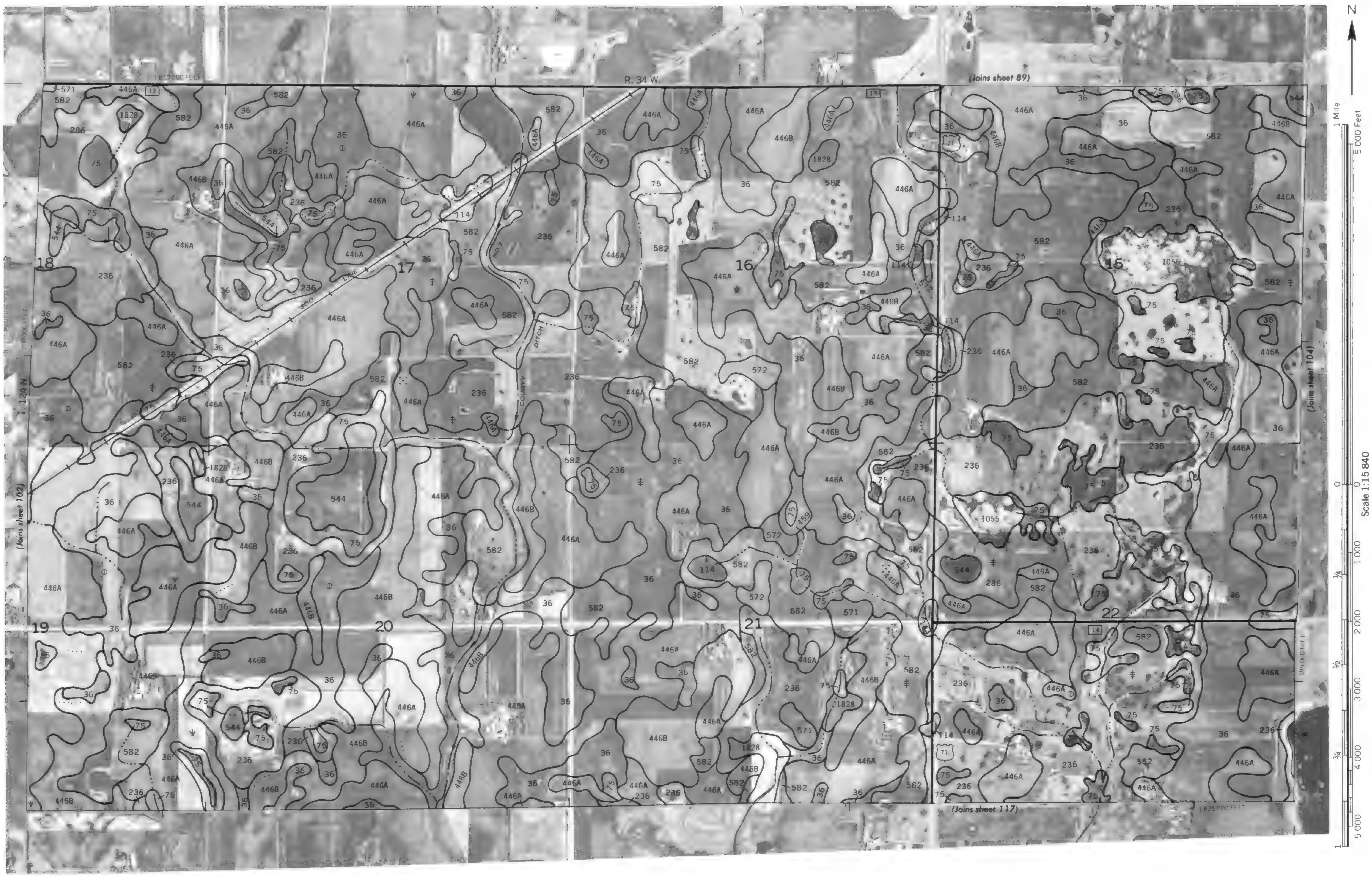

9
N
SAUK
LAKE
SAUK
CENTRE
MINNESOTA
CORRECTIONAL
FACILITY
SAUK
RIVER
Hoboken
Creek
BURLINGTON
NORTHERN
SAINT PAUL'S CEMETERY
CALVARY CEMETERY
GREENWOOD CEMETERY
R. 34 W.
T. 126 N.
(Joins sheet 2)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 22)
water
1 Mile
5 000 Feet
Scale 1:15 840

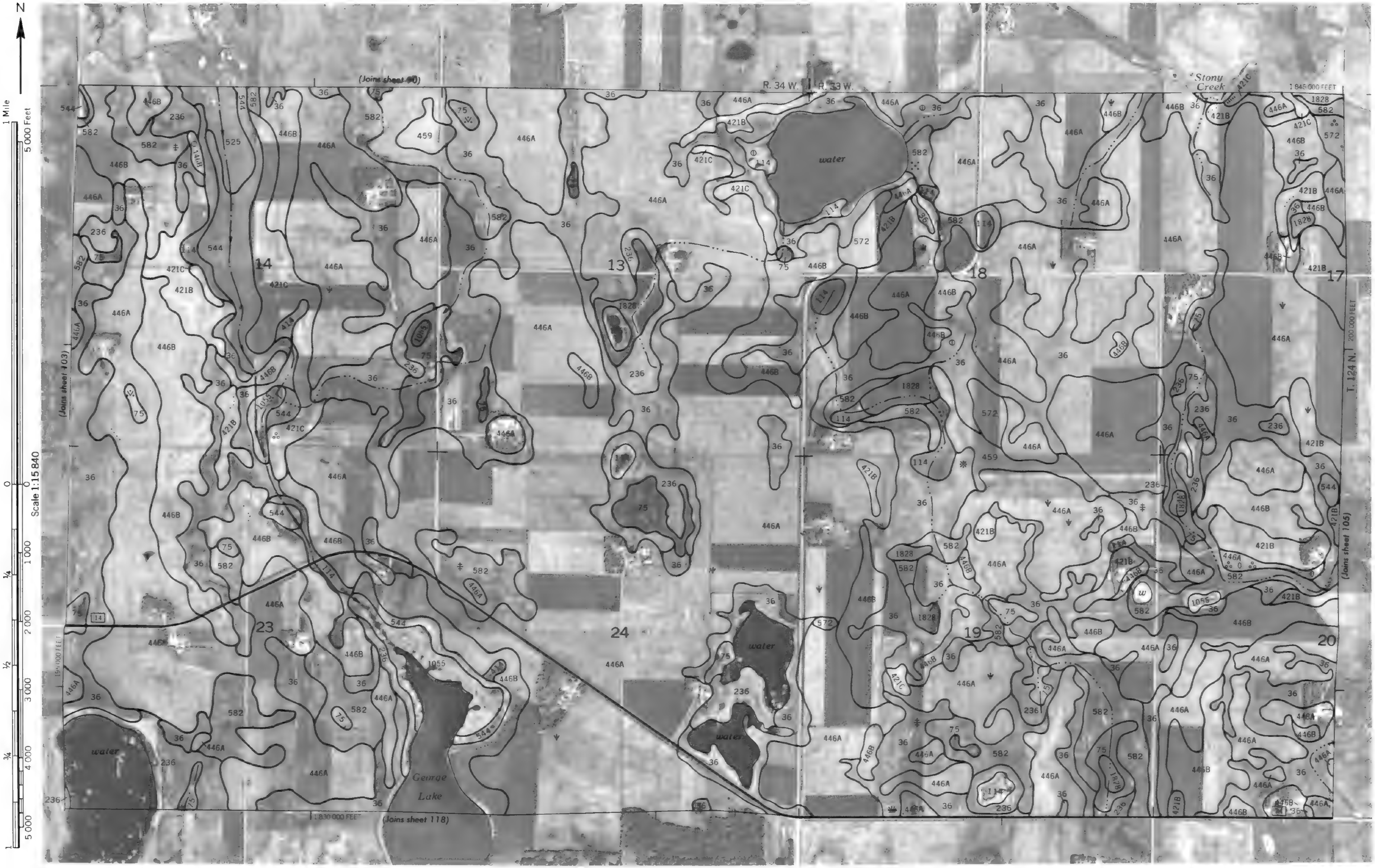

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins inset, sheet 2)
R. 34 W.
R. 33 W.
CEDAR
LAKE
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 23)
T. 126 N.


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 86)
R. 28 W.
SAUK RIVER
MISSISSIPPI RIVER
BENTON COUNTY
SAINT CLOUD AREA VOCATIONAL TECHNICAL INSTITUTE
SAINT CLOUD
(county seat)
BURLINGTON NORTHERN
41A
41B
465
848
850
865B
179B
1
2
3
4
9
10
11
12


(Joins sheet 87)
R. 35 W.
1 775 000 FEET
T. 124 N.
200 000 FEET
POPE COUNTY
Sedan Brook
North Fork Crow River
16
17
18
19
20
21
(Joins sheet 102)
(Joins sheet 115)
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 88)
(Joins sheet 101)
(Joins sheet 103)
(Joins sheet 116)
R. 35 W.
R. 34 W.
T. 124 N.
15
14
13
18
22
23
24
19
BIG GROVE CEMETERY
North Fork Crow River
Sedan Brook
SOO LINE
COUNTY DITCH NO 34

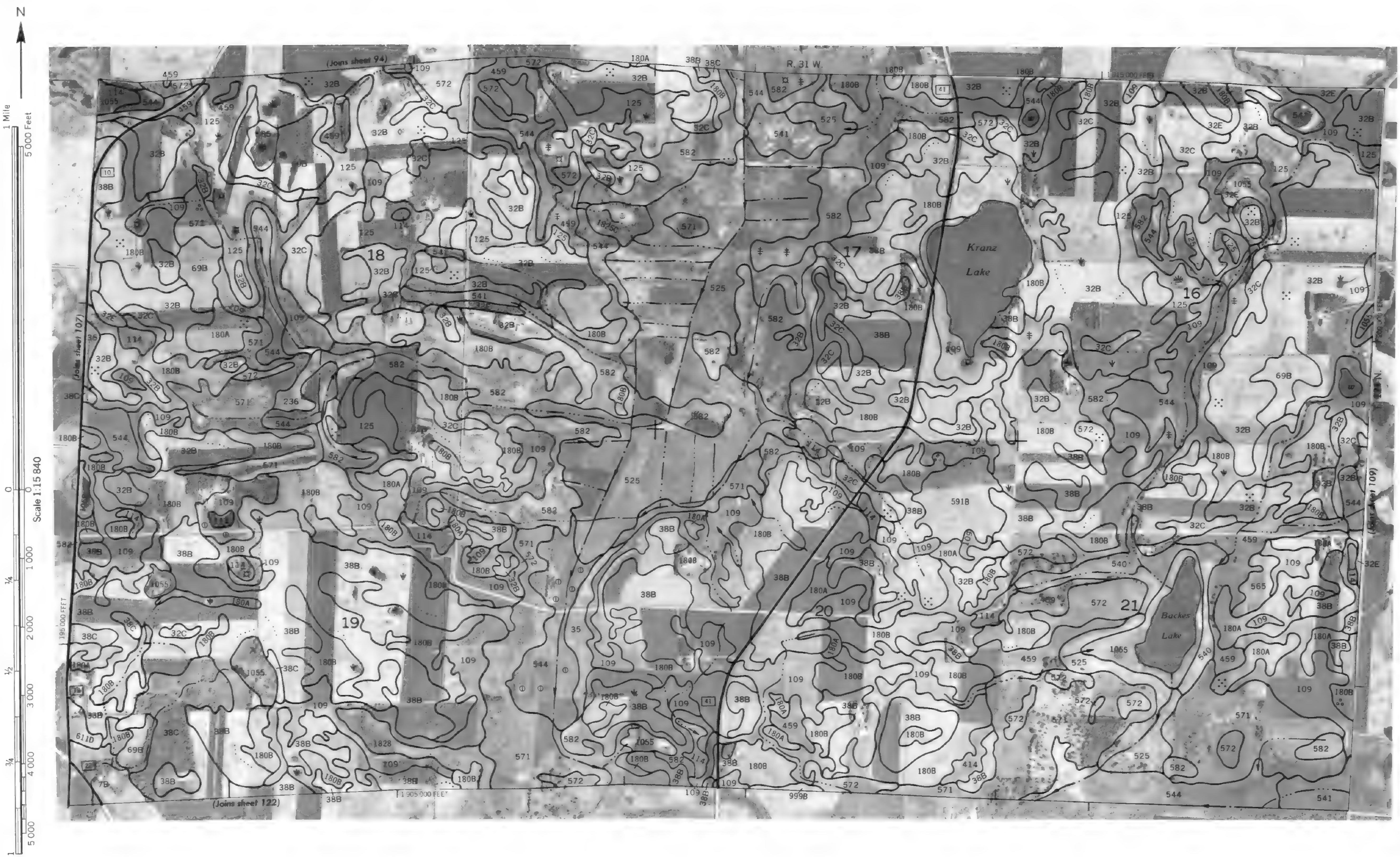

(Joins sheet 89)
R. 34 W.
(Joins sheet 104)
(Joins sheet 117)
(Joins sheet 102)
T. 124 N.
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 90)
R. 34 W.
R. 33 W.
Stony Creek
1 845 000 FEET
T. 124 N.
200 000 FEET
(Joins sheet 103)
(Joins sheet 105)
(Joins sheet 118)
1 830 000 FEET
150 000 FEET
water
George Lake
14
13
18
17
23
24
19
20


R. 33 W.
(Joins sheet 91)
(Joins sheet 104)
(Joins sheet 106)
(Joins sheet 119)
T. 124 N.
1 845 000 FEET
1 860 000 FEET
COUNTY DITCH NO 31
SAUK R
Creek
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 92)
R. 33 W.
R. 32 W.
(Joins sheet 105)
(Joins sheet 107)
(Joins sheet 120)
SAUK RIVER
SAUK R
Stony Creek
13
18
17
16
24
19
20
21
T. 124 N.


N
R. 32 W.
(Joins sheet 93)
(Joins sheet 108)
(Joins sheet 121)
(Joins sheet 106)
T. 124 N.
SAUK RIVER
16
15
14
13
21
22
23
24
1 Mile
5 000 Feet
Scale 1:15 840

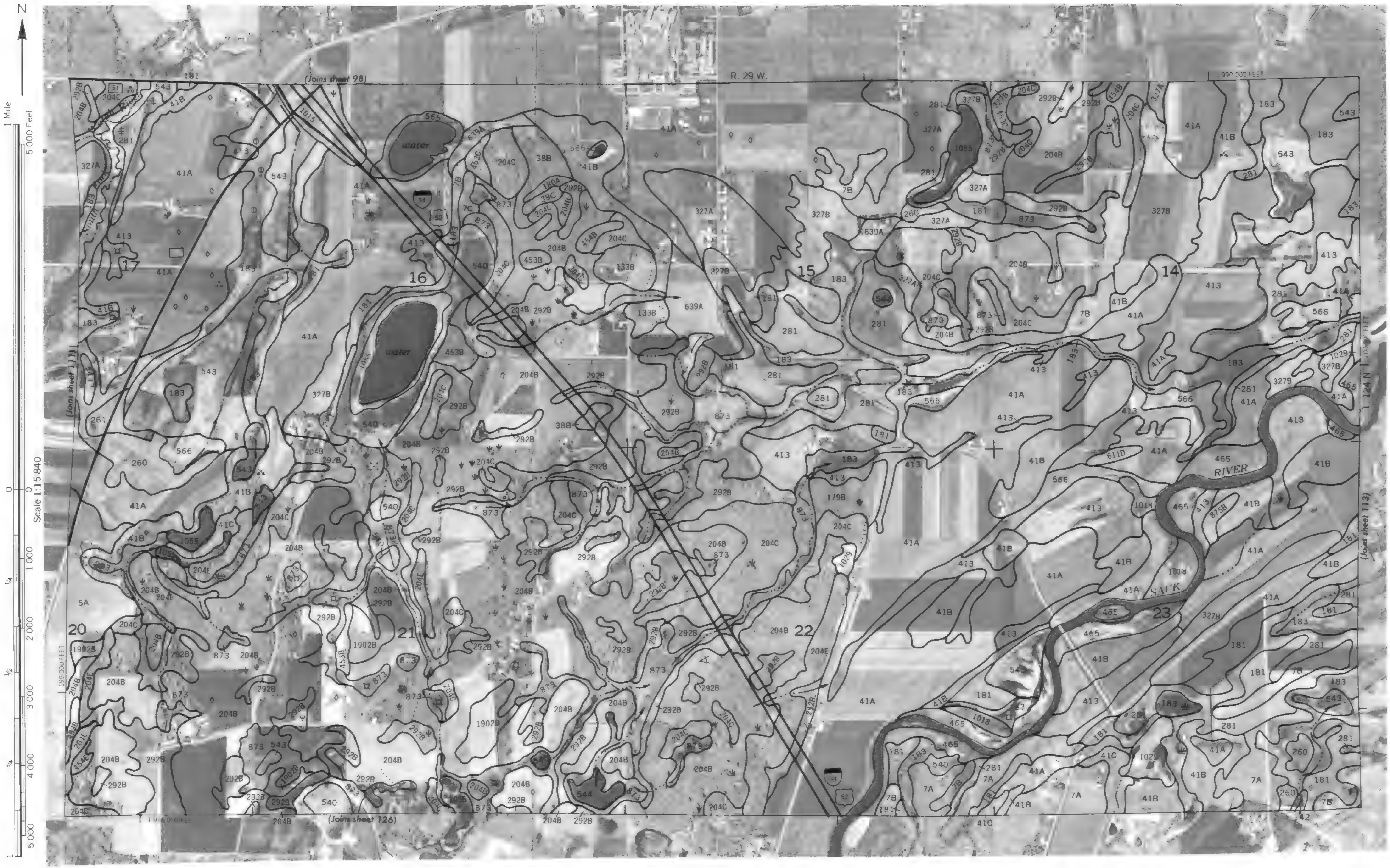

N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1
(Joins sheet 94)
(Joins sheet 122)
(Joins sheet 107)
(Joins sheet 109)
R. 31 W.
Kranz Lake
Backes Lake
16
17
18
19
20
21
1 905 000 FEET
195 000 FEET

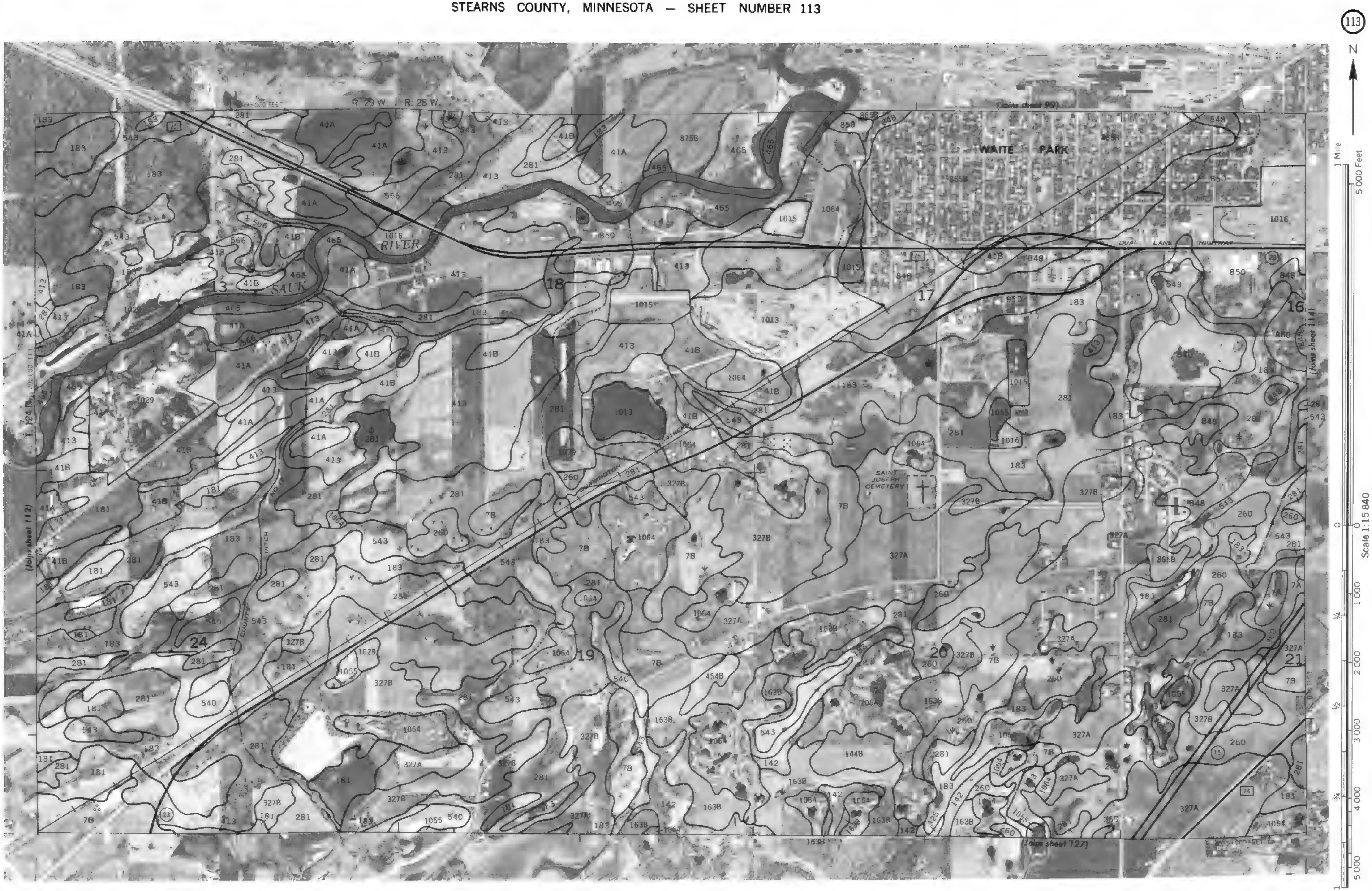

N
(Joins sheet 95)
(Joins sheet 110)
(Joins sheet 123)
(Joins sheet 108)
R. 31 W.
R. 30 W.
T. 124 N.
Minnie Lake
Little Rice Lake
Koop Lake
Big Rice Lake
Mud Lake
Clear Lake
Spunk Branch
water
13
14
15
18
19
22
23
24
1 Mile
5 000 Feet
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000
Scale 1:15 840


R. 33 W
T. 126 N
(Joins sheet 3)
(Joins sheet 12)
(Joins sheet 24)
(Joins sheet 10)
Little Birch Lake
Sylvia Lake
Adley Creek
N
1 Mile
5 000 Feet
Scale 1:15 840

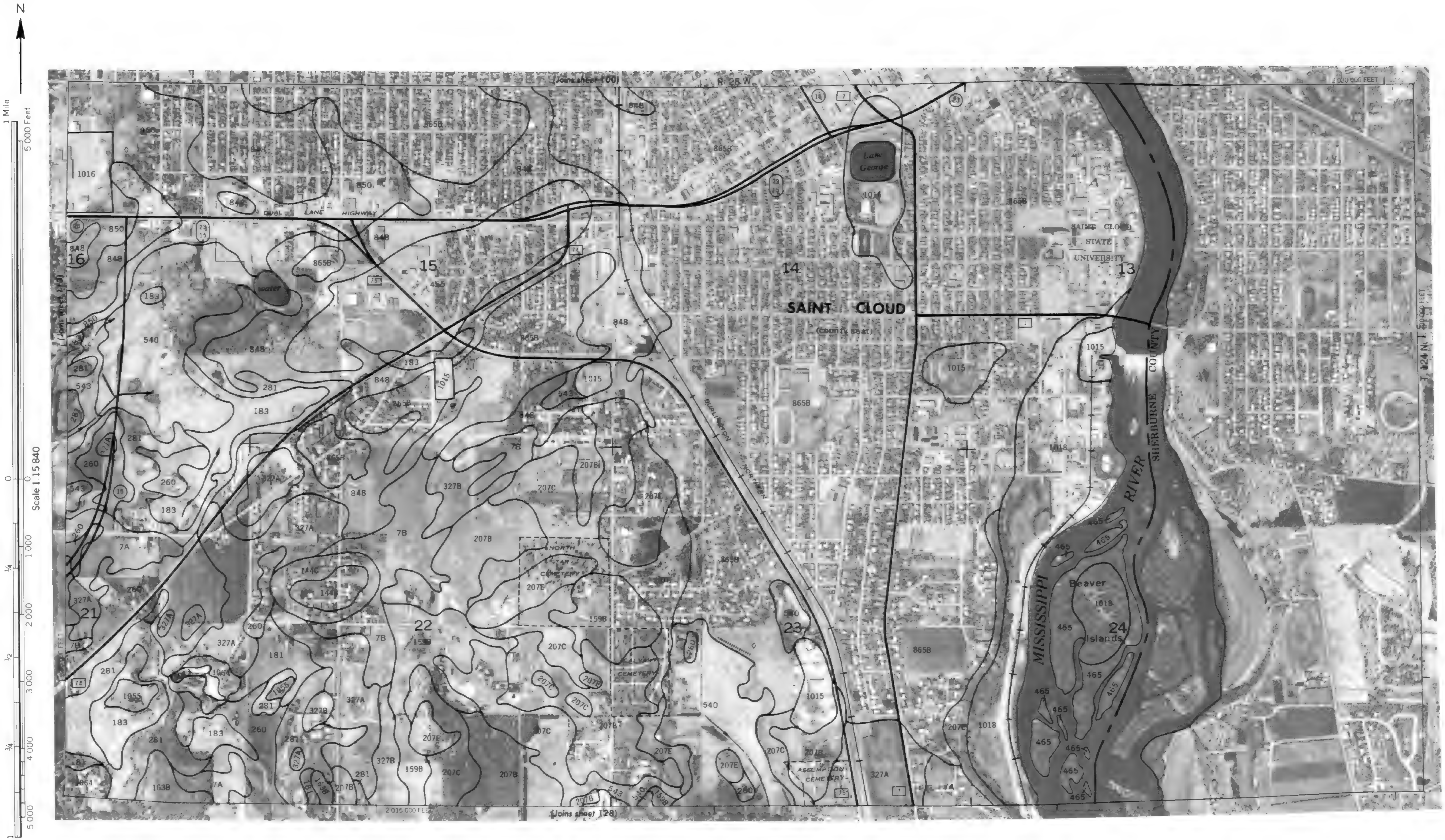
STEARNS COUNTY, MINNESOTA — SHEET NUMBER 110


N
Island
Lake
Long
Lake
KRAEMER
LAKE
Dullinger
Lake
Zimmer
Lake
water
COLLEGEVILLE
TOWNSHIP
SAINT
JOSEPH
REFUGE
Watab River
South Fork
R. 30 W.
R. 29 W.
T. 124 N.
(Joins sheet 97)
(Joins sheet 125)
(Joins sheet 110)
(Joins sheet 112)
13
14
17
18
19
20
23
24
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 98)
(Joins sheet 111)
(Joins sheet 113)
(Joins sheet 126)
R. 29 W.
T. 124 N.
water
SAUK
RIVER
16
15
14
17
21
22
23
20
South Fork


113
N
R. 29 W.
R. 28 W.
(Joins sheet 99)
WAITE PARK
SAUK
RIVER
DUAL LANE HIGHWAY
SAINT JOSEPH CEMETERY
(Joins sheet 112)
(Joins sheet 114)
(Joins sheet 127)
1 Mile
5 000 Feet
Scale 1:15 840

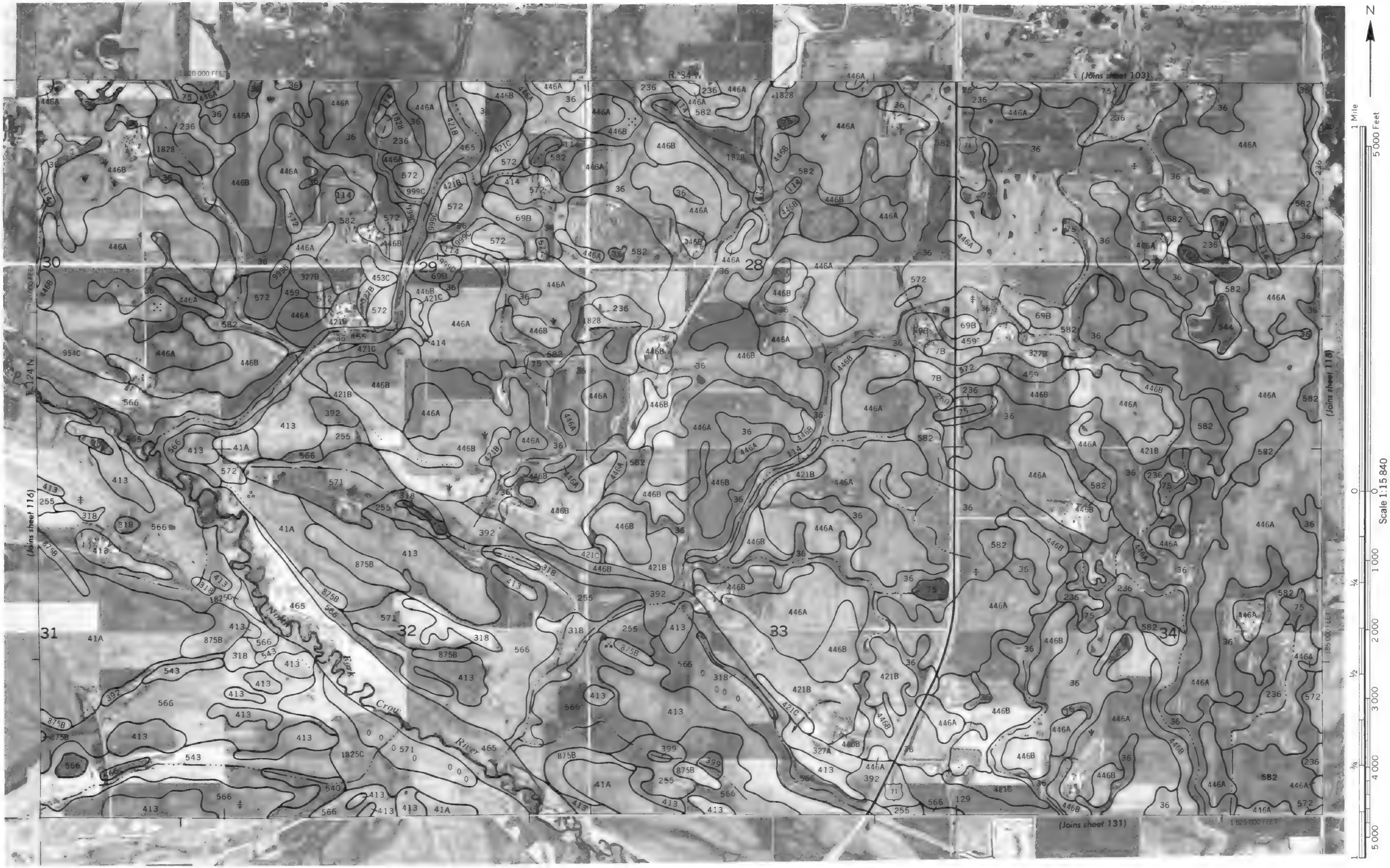
(114)


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 100)
(Joins sheet 128)
SAINT CLOUD
(county seat)
SAINT CLOUD STATE UNIVERSITY
Lake George
DUAL LANE HIGHWAY
BURLINGTON NORTHERN
NORTH STAR CEMETERY
CALVARY CEMETERY
ASSUMPTION CEMETERY
MISSISSIPPI RIVER
SHERBURNE COUNTY
Beaver Islands
R. 28 W.
2 015 000 FEET
2 030 000 FEET

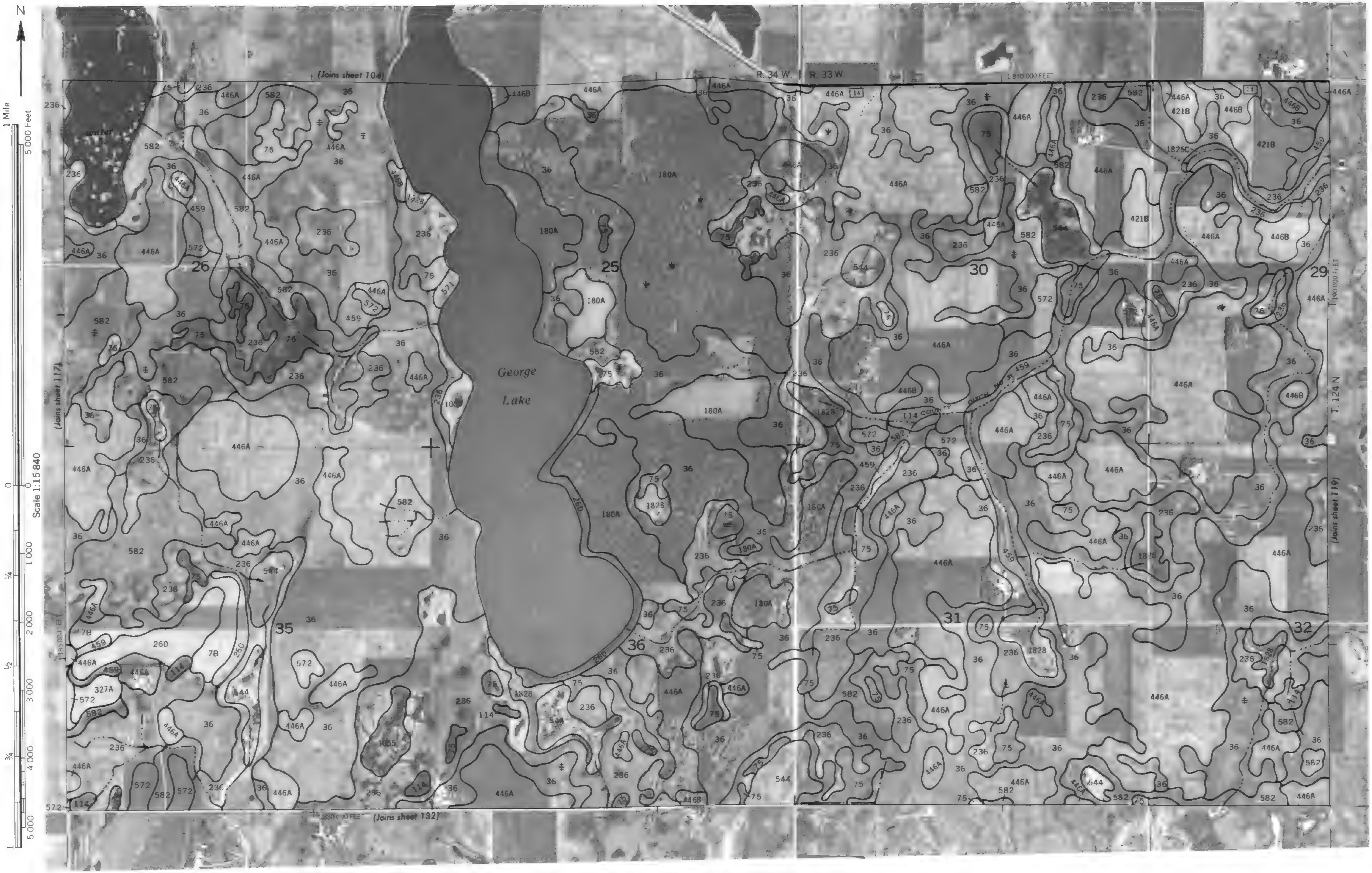

N
(Joins sheet 101)
(Joins sheet 116)
(Joins sheet 129)
1 775 000 FEET
1 785 000 FEET
R. 35 W.
T. 124 N.
POPE COUNTY
COUNTY DITCH NO 36
COUNTY DITCH NO 18
COUNTY DITCH NO 7
COUNTY DITCH NO 37
SOO LINE
Brooten
28
29
30
31
32
33
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾
1

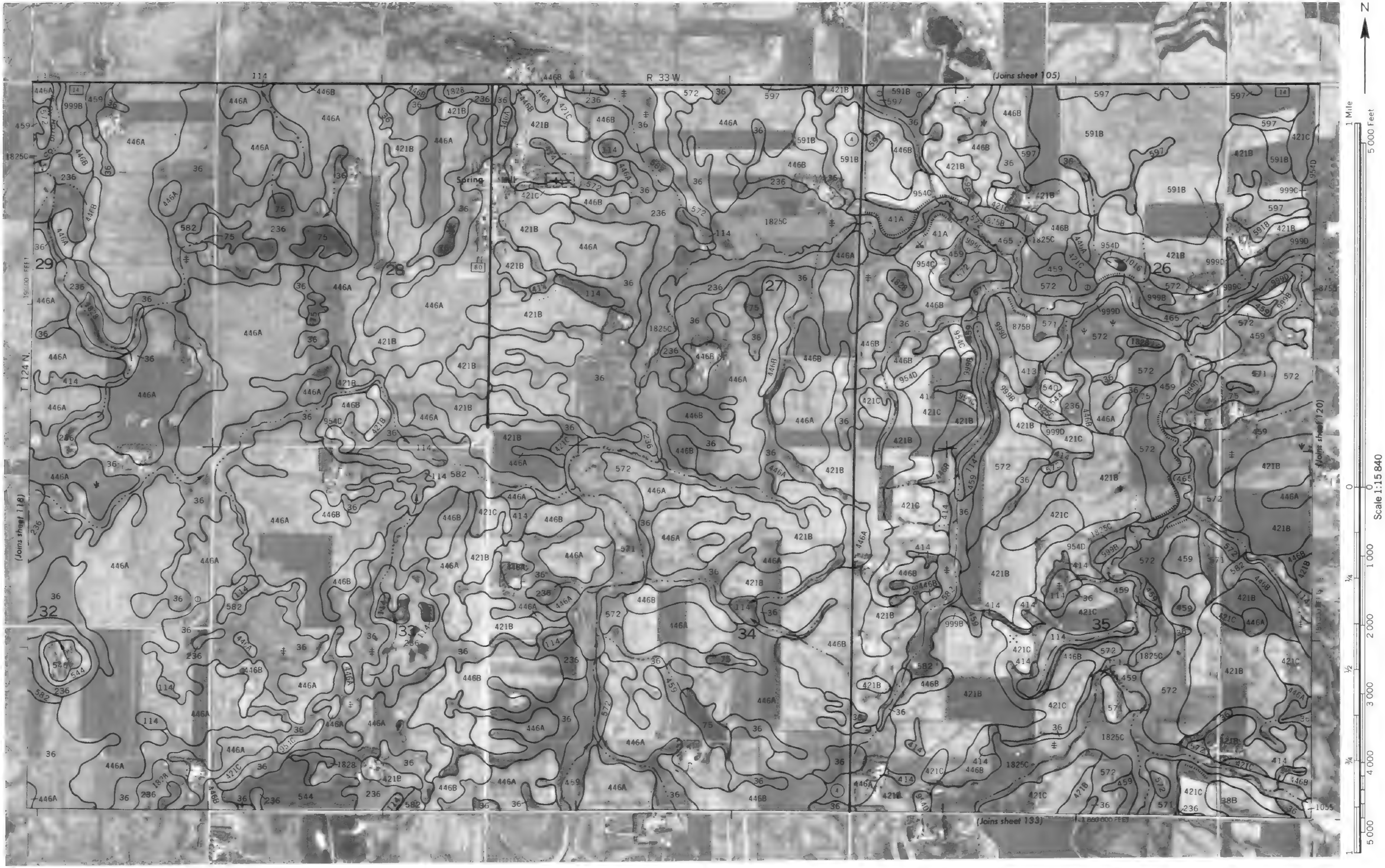

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 102)
(Joins sheet 130)
(Joins sheet 115)
(Joins sheet 117)
R. 35 W
R. 34 W.
T. 124 N.
1 805 000 FEET
1 790 000 FEET
North Fork Crow River
SOO LINE
COUNTY DITCH NO 2
27
26
25
30
34
35
36
31

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 117



STEARNS COUNTY, MINNESOTA — SHEET NUMBER 118

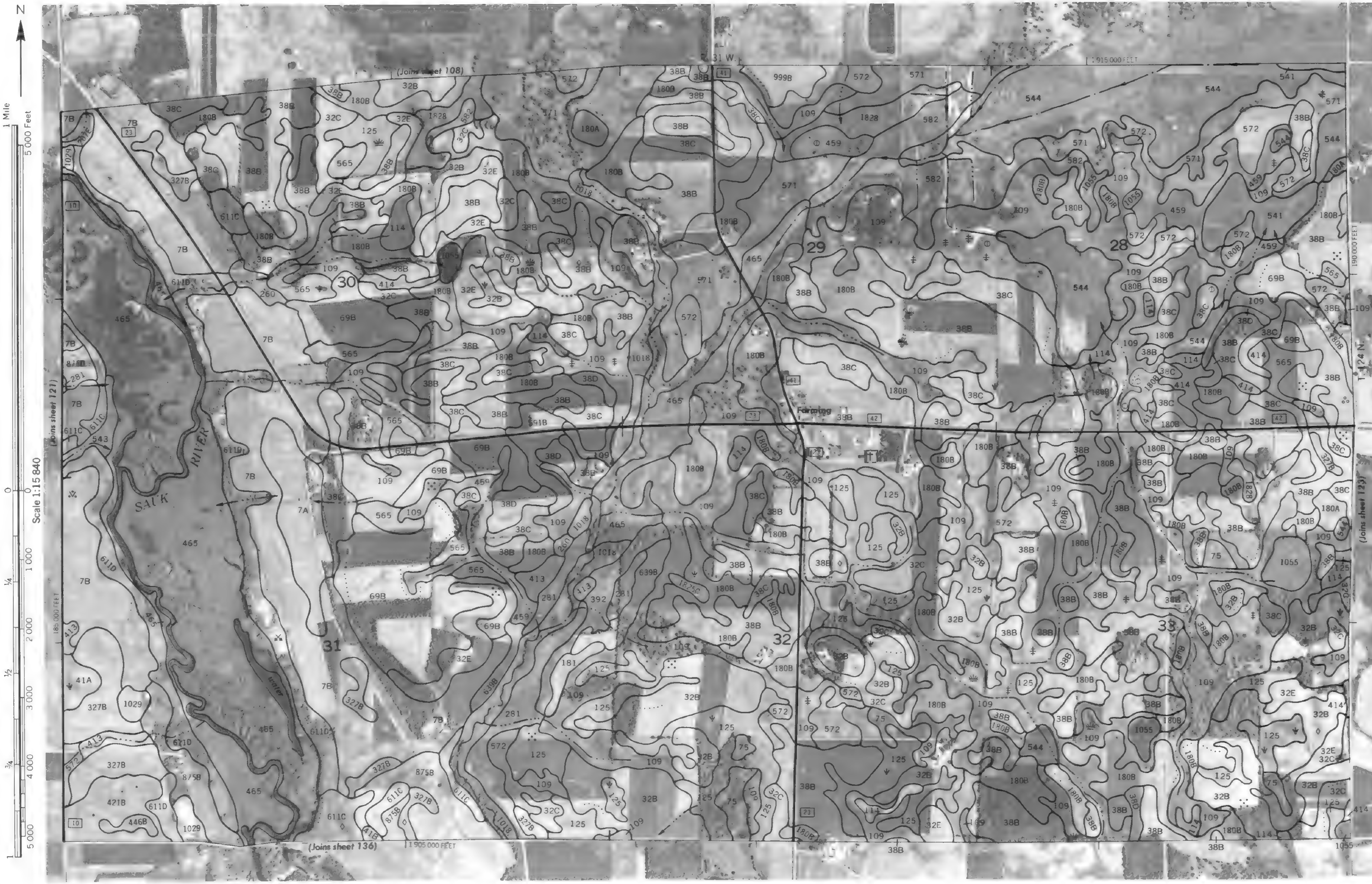


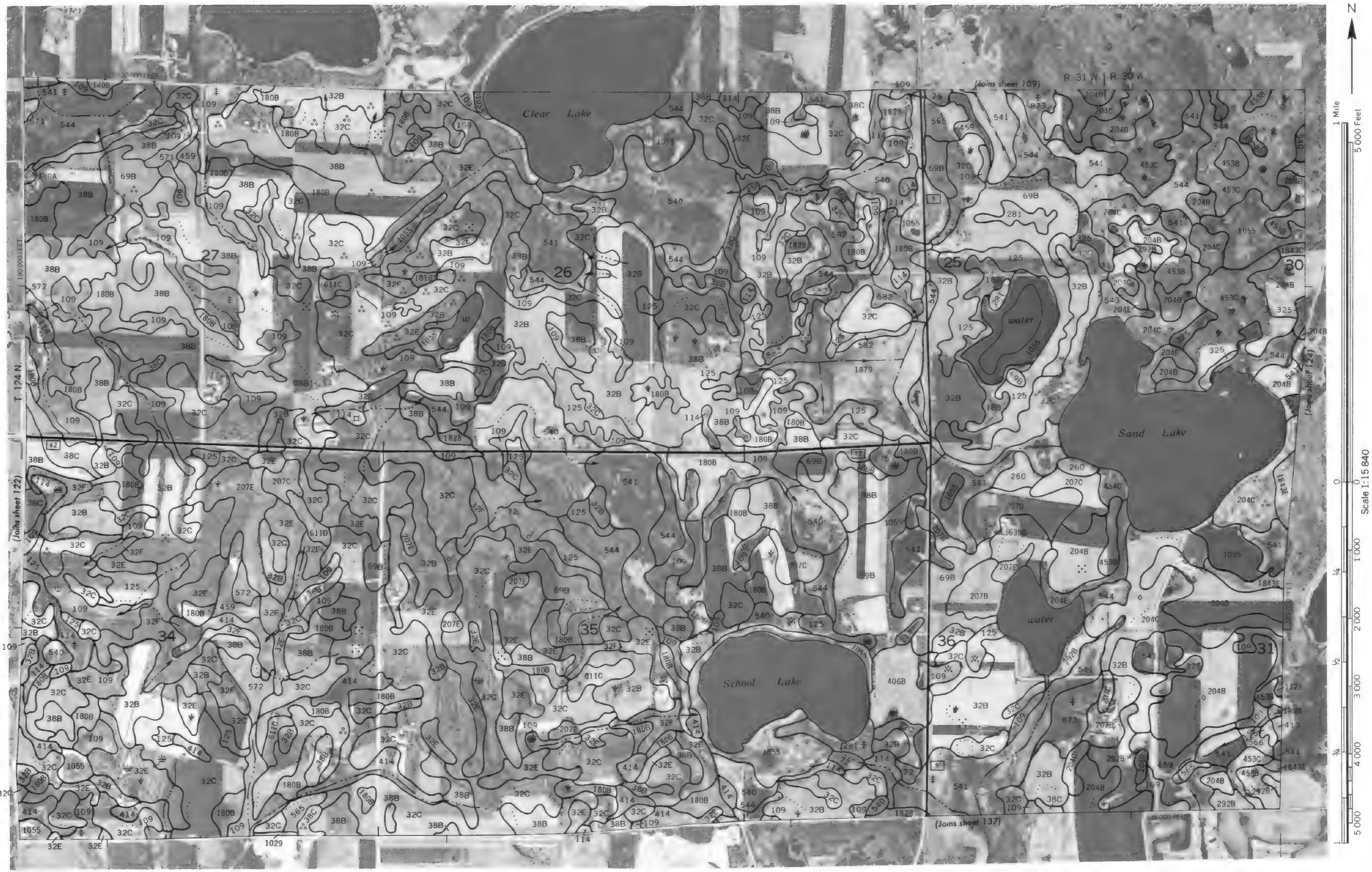

(Joins sheet 105)
R 33 W.
T 124 N.
(Joins sheet 118)
(Joins sheet 120)
(Joins sheet 133)
Spring
N
1 Mile
5 000 Feet
Scale 1:15 840
26
27
28
29
32
33
34
35


N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1000
2000
3000
4000
5000
R. 33 W
R. 32 W.
(Joins inset, sheet 3)
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 23)
1 880 000 FEET
1 870 000 FEET
T. 125 N.
Big Birch Lake
McKenny Lake
Tamarack Lake
Saint Rosa
water
1
4
5
6
7
8
9
12

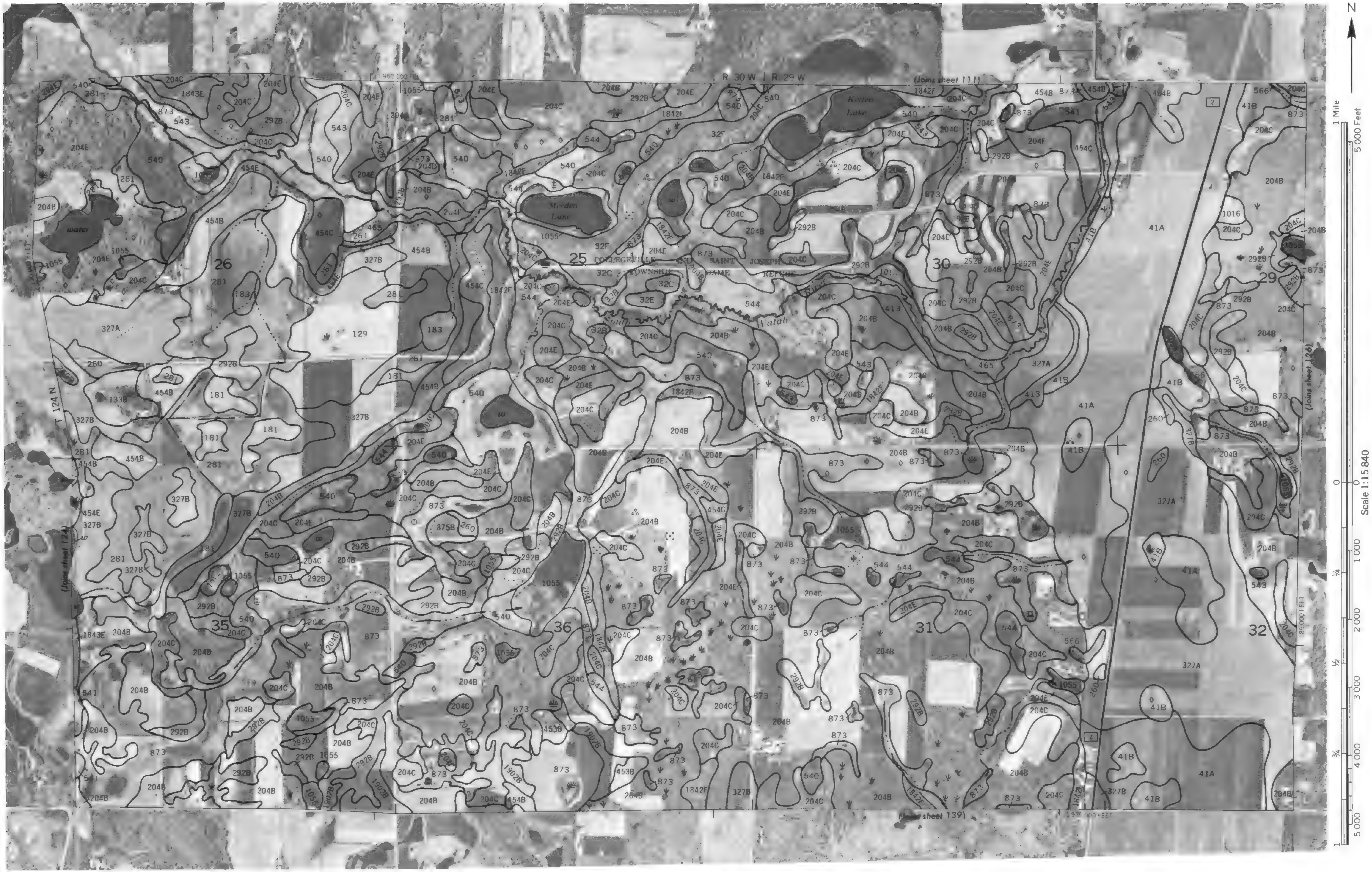

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 106)
R. 33 W.
R. 32 W.
(Joins sheet 119)
(Joins sheet 121)
(Joins sheet 134)
T. 124 N.
SAUK RIVER
25
29
30
28
31
32
33
36


(Joins sheet 107)
(Joins sheet 122)
(Joins sheet 135)
(Joins sheet 120)
R. 32 W.
T. 124 N.
SAUK RIVER
Saint Martin
25
26
27
28
33
34
35
36
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 108)
(Joins sheet 136)
(Joins sheet 121)
(Joins sheet 123)
1 915 000 FEET
1 905 000 FEET
190 000 FEET
185 000 FEET
R. 31 W.
T. 124 N.
SAUK RIVER
Farming
water
28
29
30
31
32
33


N
(Joins sheet 109)
R. 31 W. | R. 30 W.
T. 124 N.
(Joins sheet 122)
(Joins sheet 124)
(Joins sheet 137)
Clear Lake
Sand Lake
School Lake
water
27
26
25
30
34
35
36
31
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

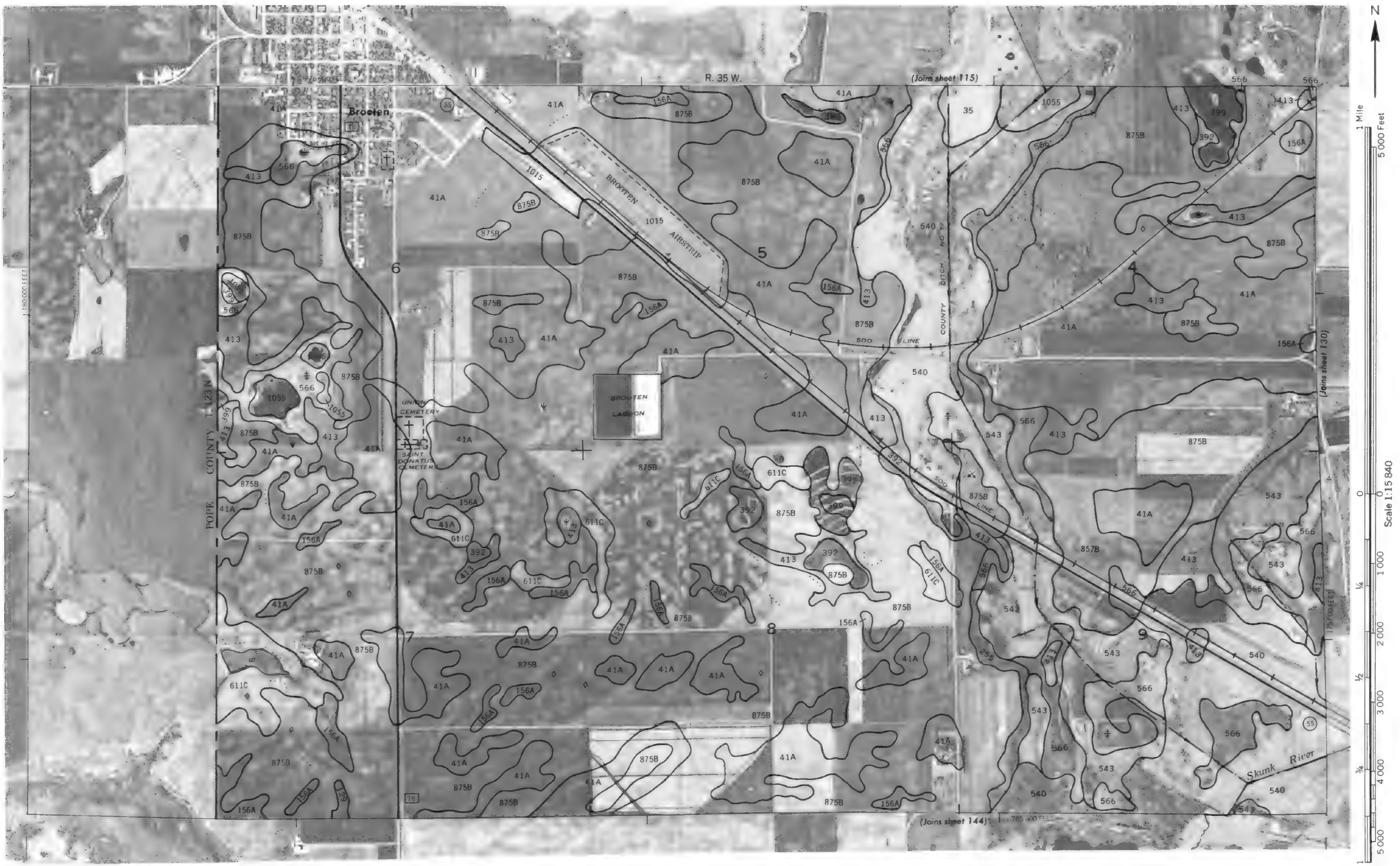
STEARNS COUNTY, MINNESOTA — SHEET NUMBER 124


N
R. 30 W. | R. 29 W.
(Joins sheet 111)
(Joins sheet 126)
(Joins sheet 139)
(Joins sheet 124)
T. 124 N.
Kellen Lake
Mayden Lake
COLLEGEVILLE AND SAINT JOSEPH TOWNSHIP GAME REFUGE
South Fork Watab River
water
25
26
29
30
31
32
35
36
1 Mile
5 000 Feet
Scale 1:15 840

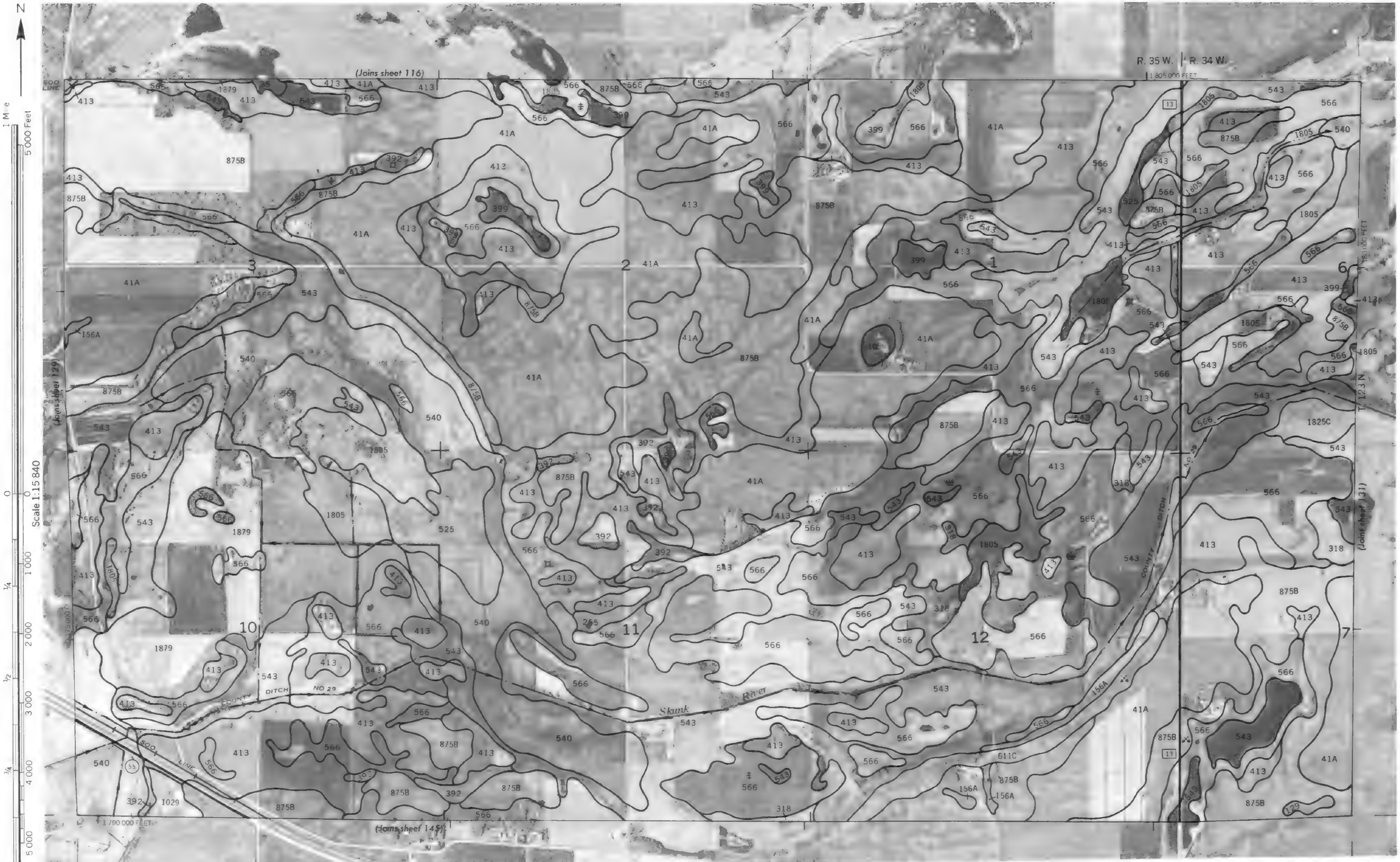

N
1 Mile
5 000 Feet
0
Scale 1:15 840
(Joins sheet 112)
(Joins sheet 140)
(Joins sheet 125)
(Joins sheet 127)
R. 29 W.
T. 124 N.
STAPLES CEMETERY
BURLINGTON NORTHERN
26
27
28
29
32
33
34
35


R. 29 W.
R. 28 W.
T. 124 N.
(Joins sheet 113)
(Joins sheet 126)
(Joins sheet 128)
Mud Lake
water
DITCH
COUNTY
NO 17
25
28
29
30
31
32
33
36
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 114)
(Joins sheet 127)
(Joins sheet 142)
R. 28 W.
BURLINGTON
NORTHERN
MISSISSIPPI
RIVER
SHERBURNE
COUNTY
28
27
26
25
33
34
35
36
2 030 000 FEET
2 015 000 FEET

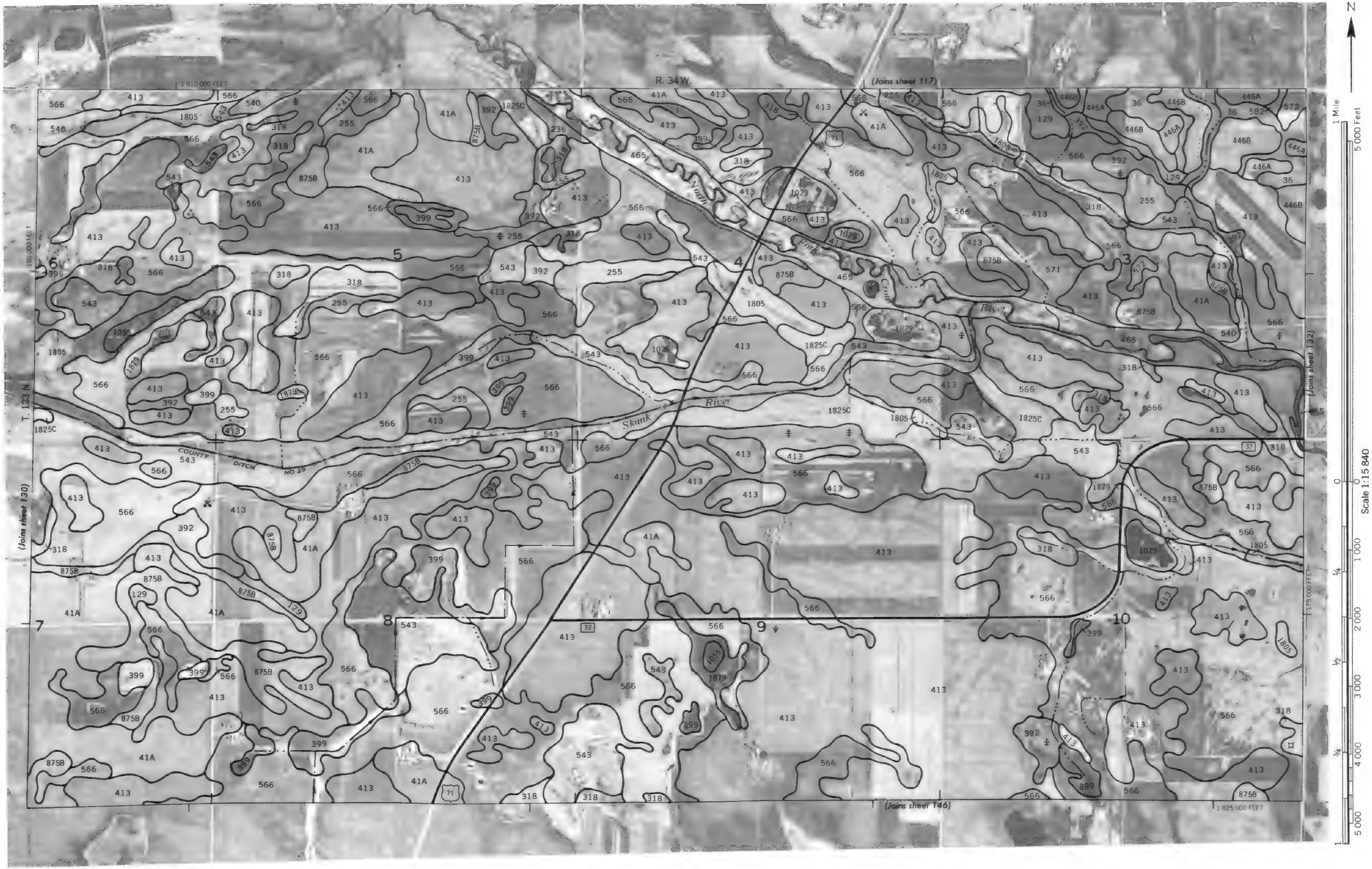

R. 35 W.
(Joins sheet 115)
(Joins sheet 130)
(Joins sheet 144)
Brooten
BROOTEN AIRSTRIP
BROOTEN LAGOON
UNION CEMETERY
SAINT DONATUS CEMETERY
SOO LINE
COUNTY DITCH NO
POPE COUNTY
T. 123 N.
Skunk River
N
1 Mile
5 000 Feet
Scale 1:15 840


N
R. 32 W.
(Joins inset, sheet 4)
T. 26 N.
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 26)
885 000 FEET
270 000 FEET
Mud Lake
Lovell Lake
water
water
water
1
2
3
10
11
12
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1000
2000
3000
4000
5000


N
(Joins sheet 116)
R. 35 W.
R. 34 W.
1 805 000 FEET
(Joins sheet 129)
(Joins sheet 131)
(Joins sheet 145)
1 790 000 FEET
T. 123 N.
Skunk River
COUNTY DITCH NO 29
SOO LINE
Scale 1:15 840
1 Mile
5 000 Feet
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 131

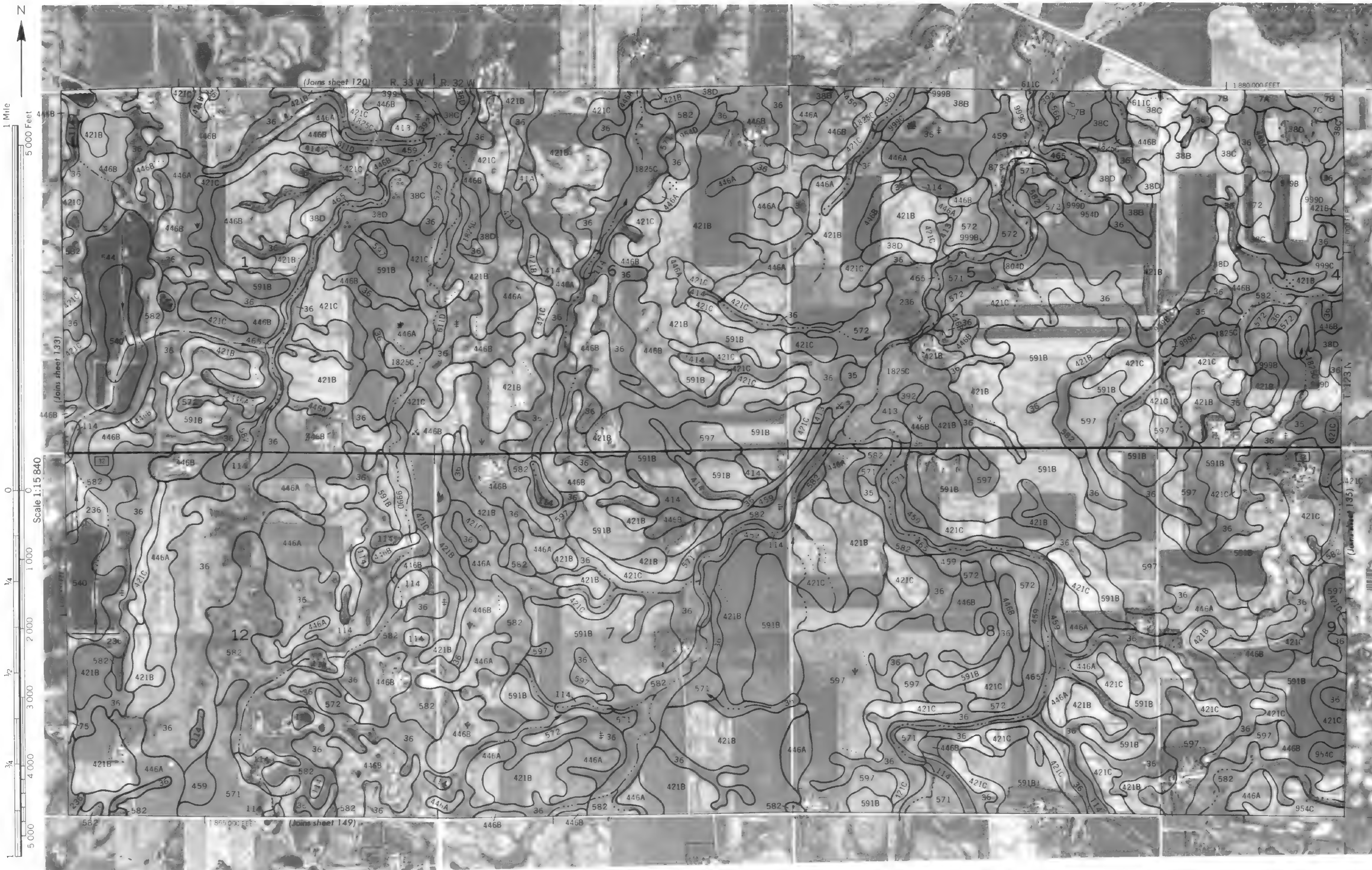
131



STEARNS COUNTY, MINNESOTA — SHEET NUMBER 132


N
R. 33 W.
(Joins sheet 119)
(Joins sheet 134)
(Joins sheet 148)
(Joins sheet 132)
T. 123 N.
Lake Henry
water
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 134




(Joins sheet 121)
(Joins sheet 136)
(Joins sheet 150)
(Joins sheet 134)
R. 32 W.
T. 123 N.
1 885 000 FEET
1 900 000 FEET
SAINT MARTIN LAGOON
water
N
1 Mile
5 000 Feet
Scale 1:15 840

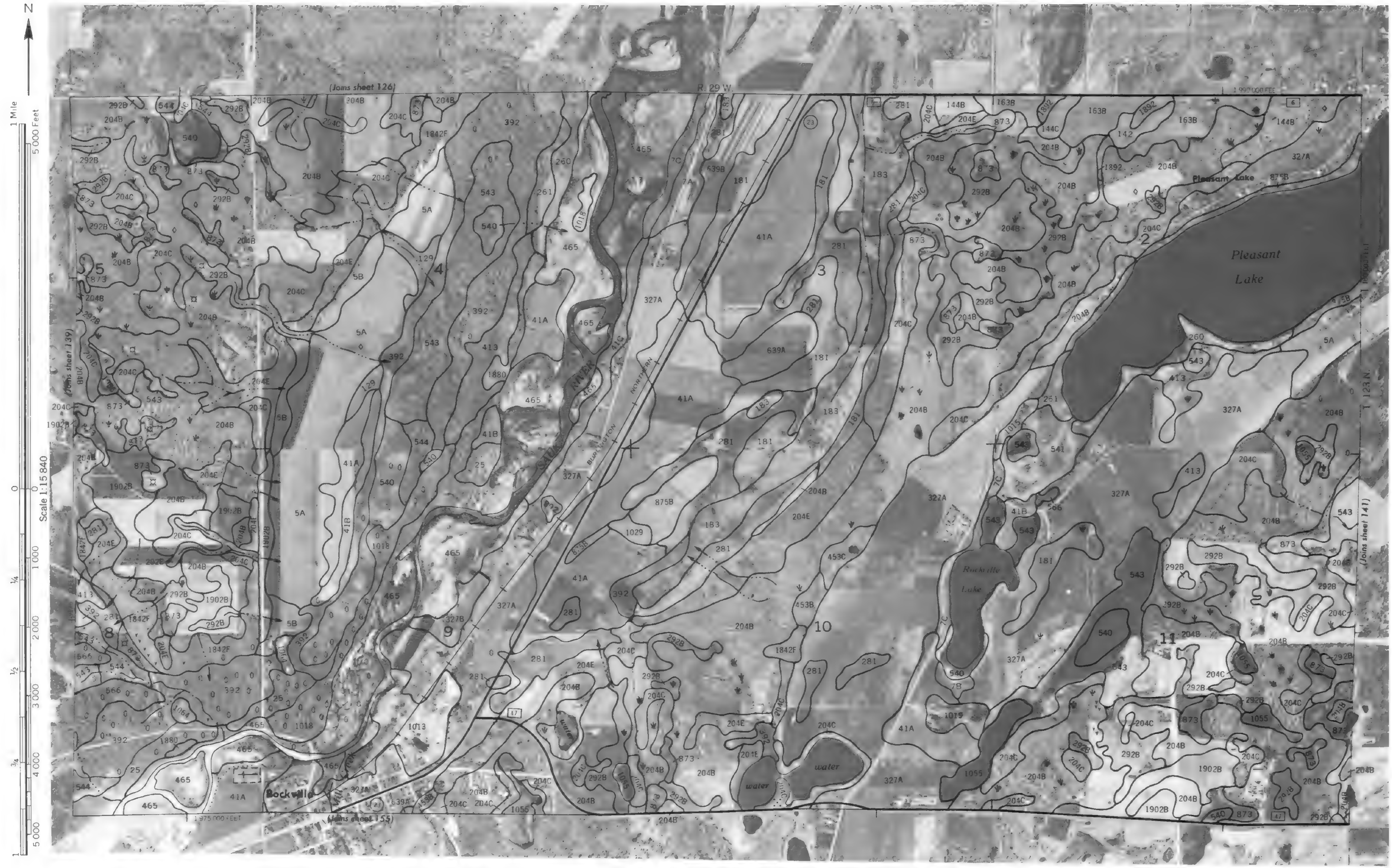

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 122)
R. 31 W.
(Joins sheet 135)
(Joins sheet 137)
T. 123 N.
(Joins sheet 151)
SAUK RIVER
6
5
4
7
8
9


(Joins sheet 123)
R. 31 W. | R. 30 W.
T. 123 N.
(Joins sheet 136)
(Joins sheet 138)
(Joins sheet 152)
SAUK RIVER
water
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 124)
(Joins sheet 153)
(Joins sheet 137)
(Joins sheet 139)
R. 30 W.
T. 123 N.
water

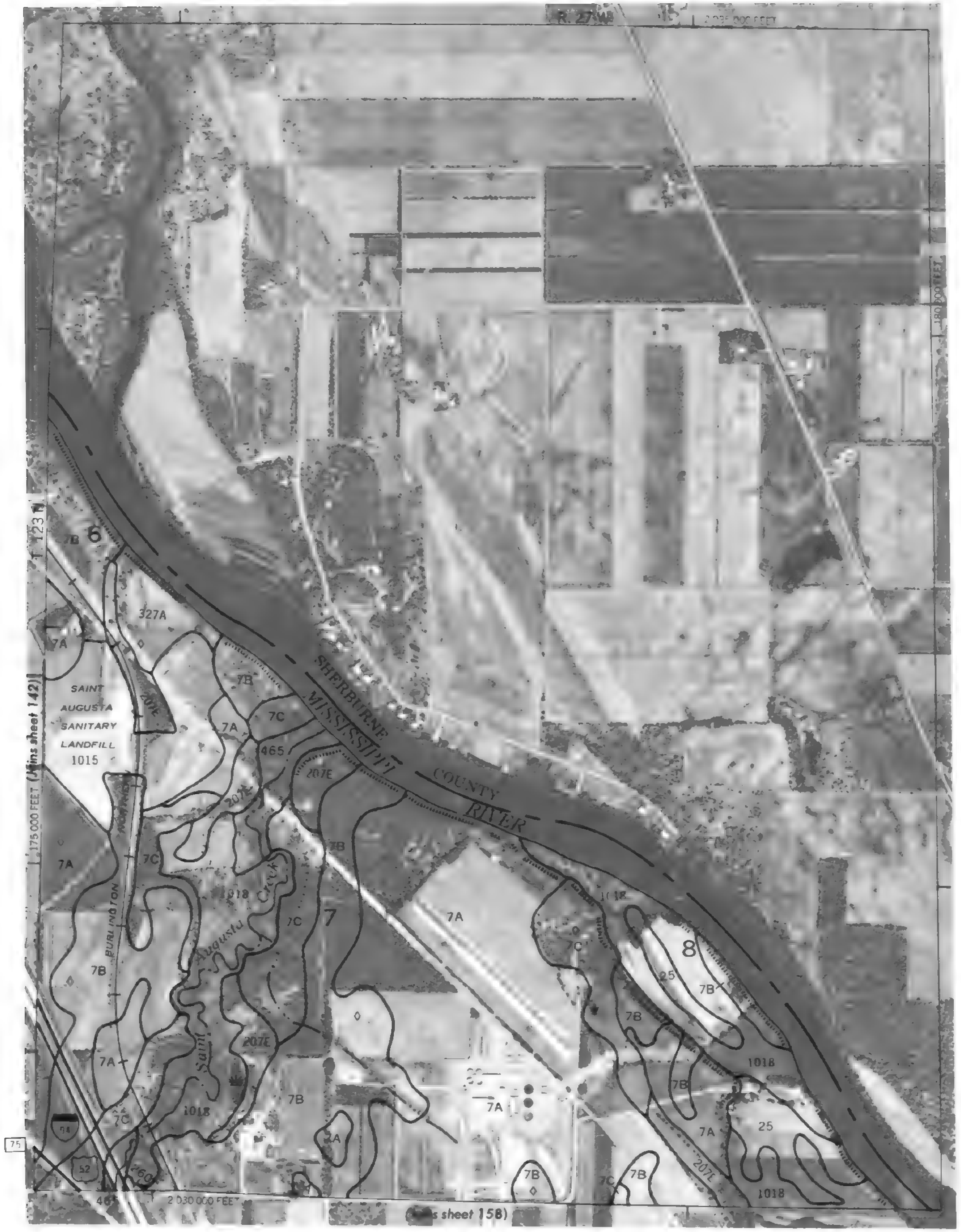

N
R. 30 W.
R. 29 W.
(Joins sheet 125)
(Joins sheet 140)
(Joins sheet 154)
(Joins sheet 138)
T. 123 N.
Jacobs
Prairie
water
1 Mile
5 000 Feet
Scale 1:15 840
970 000 FEET

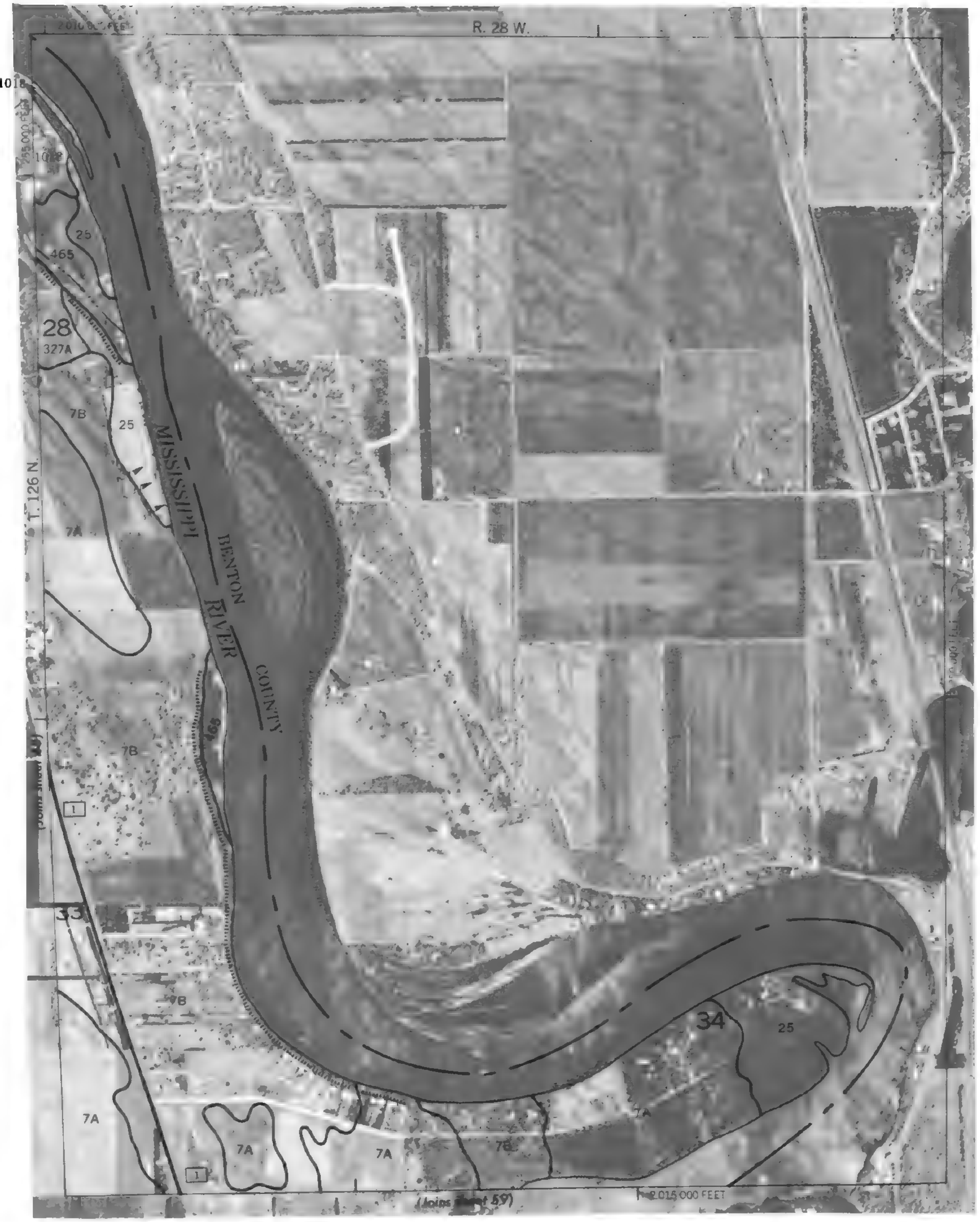

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 4)
R. 31 W.
Lake Beautiful
water
Saint Anna Lake
Saint Francis
Getchell Creek
T. 126 N.
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 27)

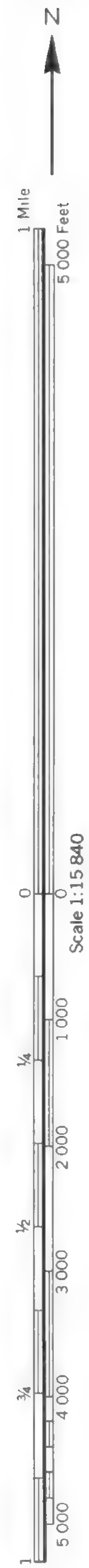

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 126)
(Joins sheet 139)
(Joins sheet 141)
(Joins sheet 155)
R. 29 W.
T. 123 N.
Pleasant Lake
Rockville Lake
Rockville
SAUK RIVER
BURLINGTON NORTHERN
water
1 975 000 FEET

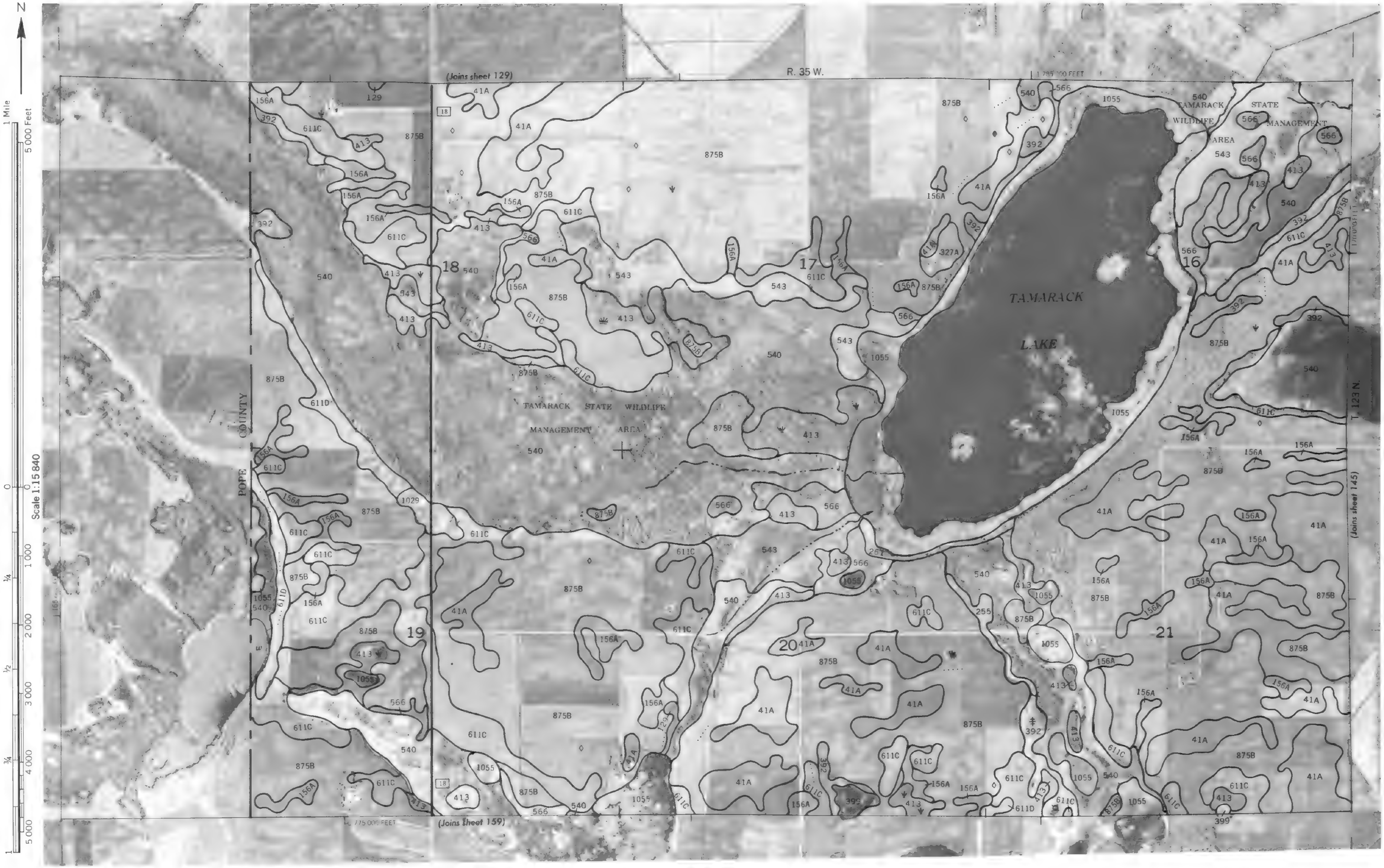

N
(Joins sheet 127)
(Joins sheet 142)
(Joins sheet 156)
(Joins sheet 140)
R. 29 W.
R. 28 W.
T. 123 N.
1 995 000 FEET
2 010 000 FEET
Pleasant Lake
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 128)
R. 28 W.
(Joins sheet 157)
(Joins sheet 143)
SAINT AUGUSTA
SANITARY
LANDFILL
1015
SAINT
MARYS
CEMETERY
Saint Augusta
SHERBURNE
COUNTY
MISS.
R
BURLINGTON
NORTHERN
Saint Augusta Creek
1
2
3
4
9
10
11
12

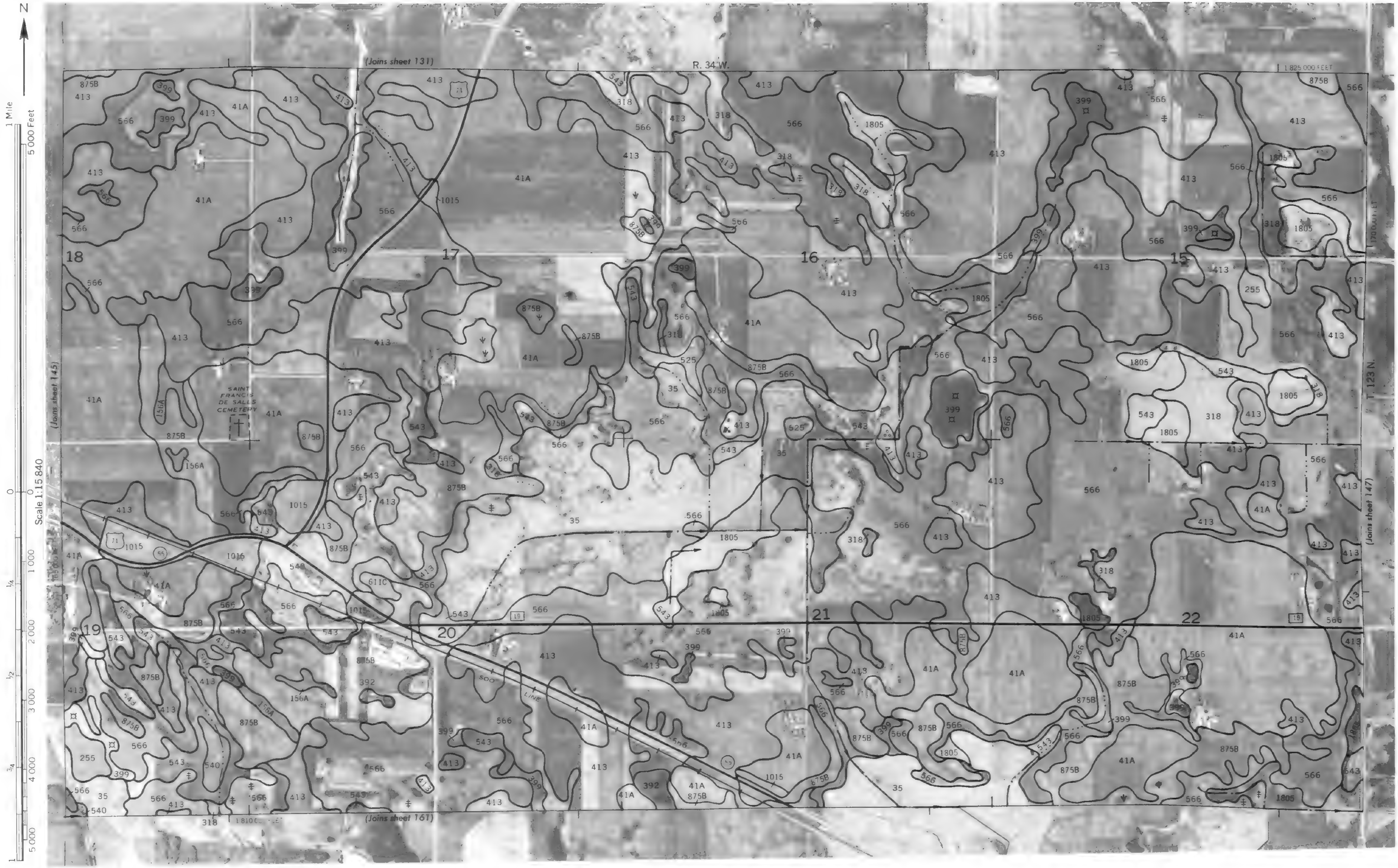

R. 27 W.
T. 123 N.
MISSISSIPPI RIVER
SHERBURNE COUNTY
SAINT AUGUSTA SANITARY LANDFILL
1015
(Joins sheet 142)
(Joins sheet 158)
175 000 FEET
2 030 000 FEET
Saint Augusta Creek
BURLINGTON NORTHERN
6
7
8
7A
7B
7C
25
327A
465
1018
207E

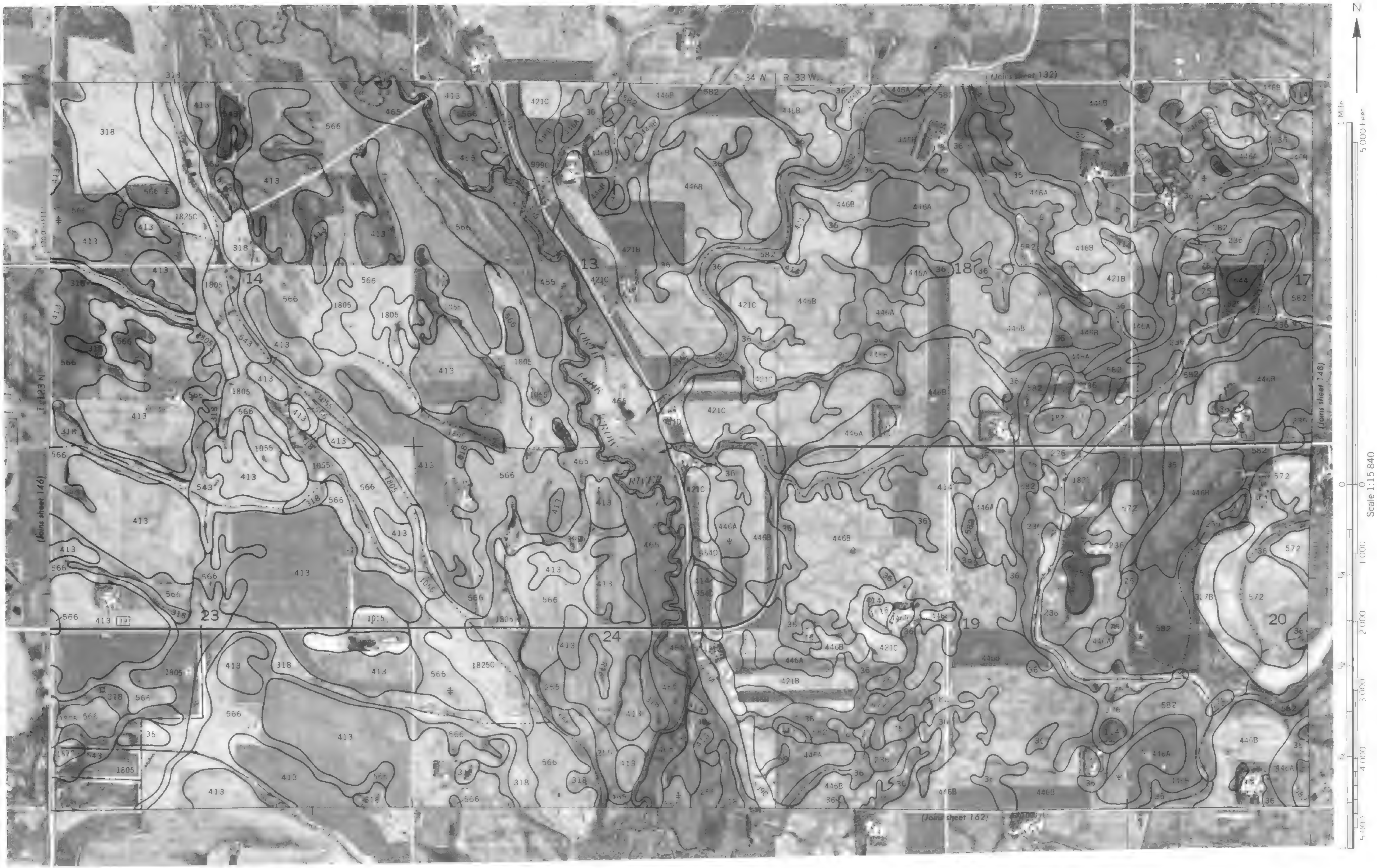

R. 28 W.
T. 126 N.
MISSISSIPPI RIVER
BENTON COUNTY
2 015 000 FEET
(Joins sheet 59)
28
33
34
7A
7B
25
327A
465
1018


N
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 129)
R. 35 W.
TAMARACK LAKE
TAMARACK STATE WILDLIFE MANAGEMENT AREA
POPE COUNTY
T. 123 N.
(Joins sheet 145)
(Joins sheet 159)
18
17
16
19
20
21

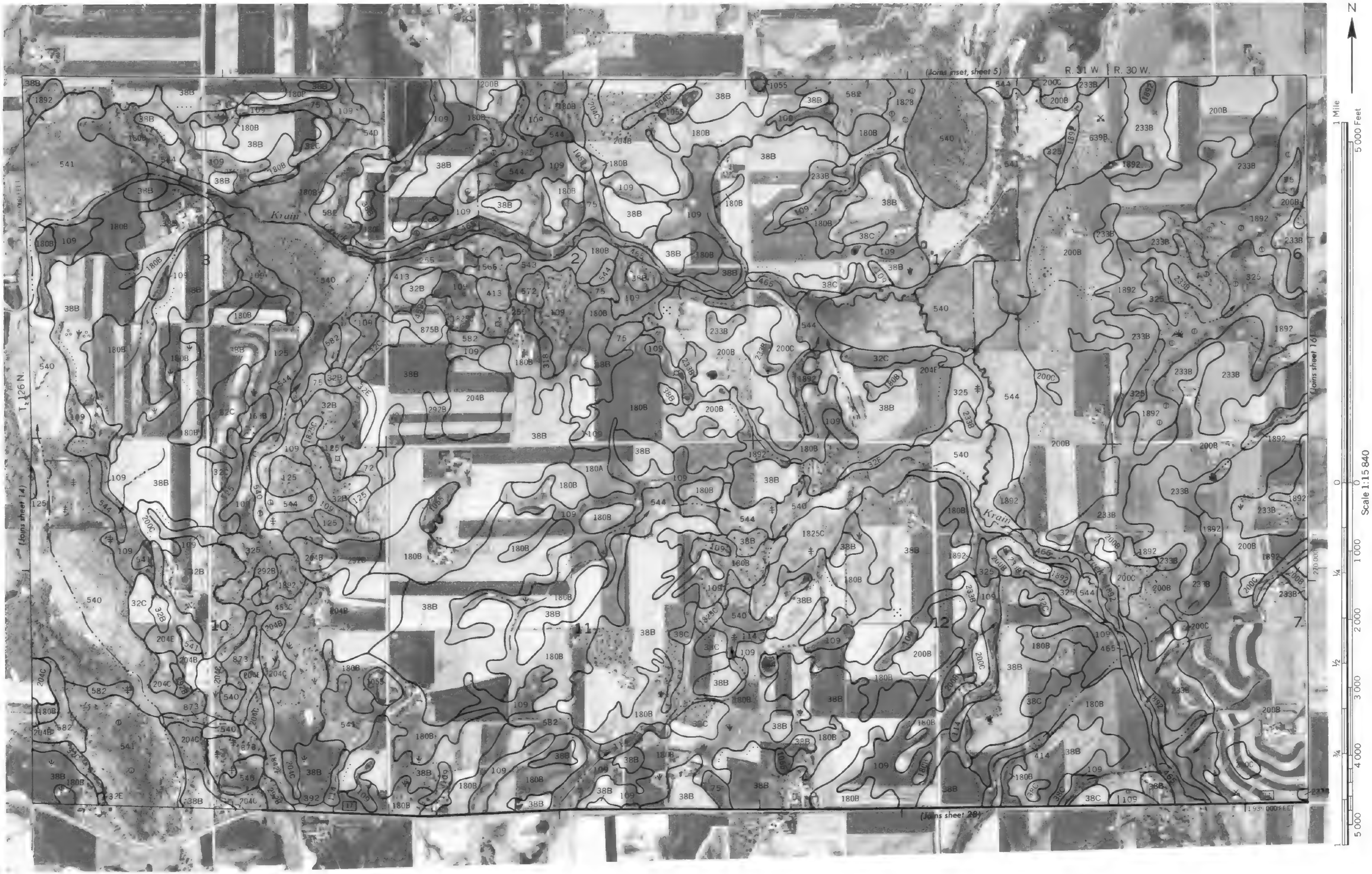

N
R. 35 W.
R. 34 W.
(Joins sheet 130)
(Joins sheet 144)
(Joins sheet 146)
(Joins sheet 160)
T. 123 N.
1 790 000 FEET
1 805 000 FEET
15
14
13
18
22
23
24
19
Belgrade
ZION CEMETERY
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1
875B
41A
413
540
543
566
611C
392
399
156A
318
1029
1013
1058
255
35
548


146
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 131)
R. 34 W.
1 825 000 FEET
T. 123 N.
(Joins sheet 145)
(Joins sheet 147)
(Joins sheet 161)
1 810 000 FEET
18
17
16
15
19
20
21
22
SAINT FRANCIS DE SALES CEMETERY
SOO LINE


34 N | R 33 W.
(Joins sheet 132)
(Joins sheet 146)
(Joins sheet 148)
(Joins sheet 162)
T 123 N
13
14
17
18
19
20
23
24
RIVER
N
1 Mile
5 000 Feet
Scale 1:15 840


N
(Joins sheet 133)
R. 33 W.
(Joins sheet 147)
(Joins sheet 149)
(Joins sheet 162)
T. 123 N.
Lake Henry
Lake Henry
SAINT MARGARET CEMETERY
17
16
15
14
20
21
22
23
1 860 000 FEET
Scale 1:15 840
1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

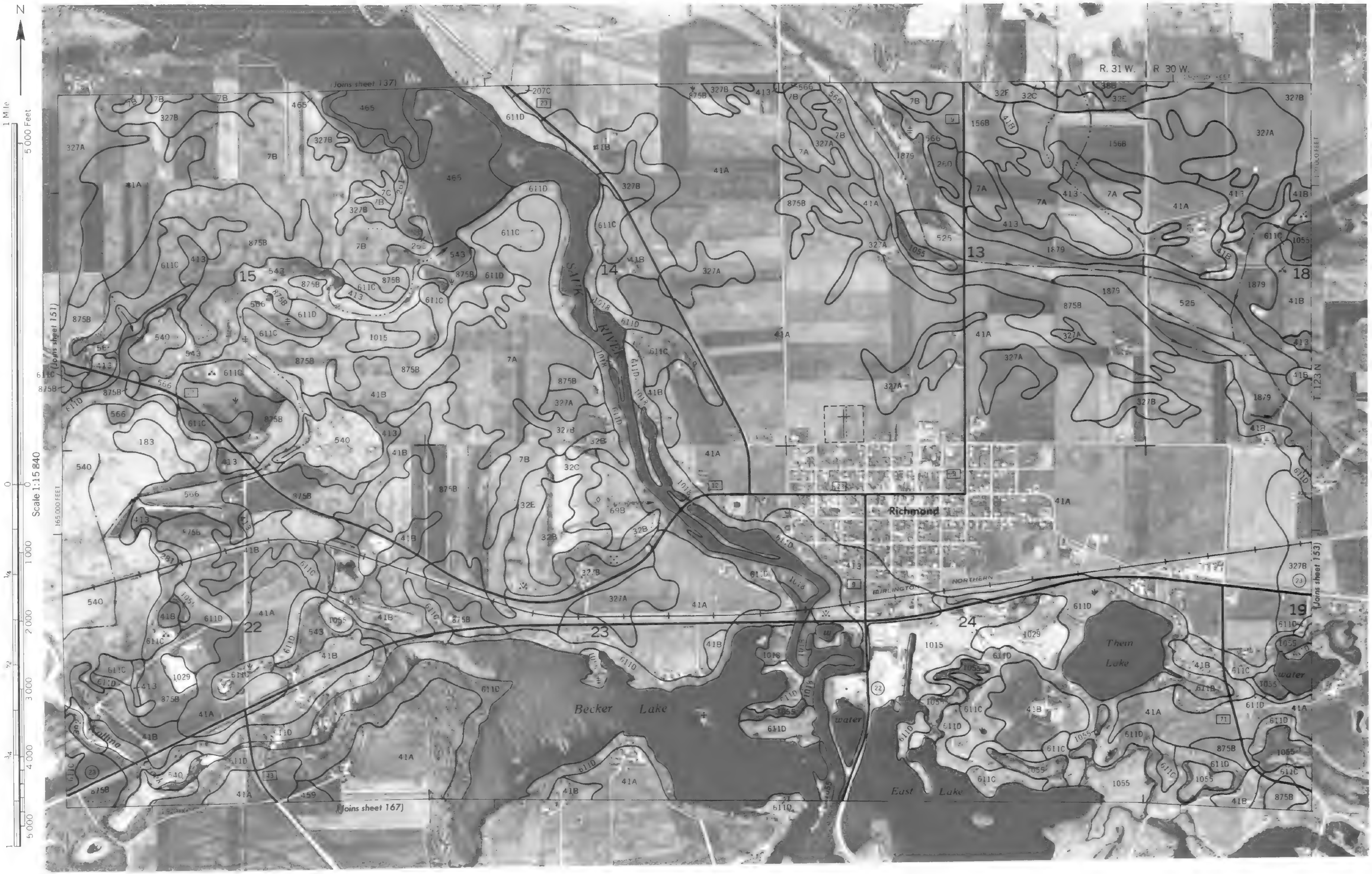

N
R. 33 W. | R. 32 W.
1 865 000 FEET
(Joins sheet 134)
(Joins sheet 148)
(Joins sheet 150)
(Joins sheet 164)
T. 123 N.
13
18
17
16
24
19
20
21
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1


(Joins inset, sheet 5)
R. 31 W.
R. 30 W.
T. 126 N.
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 20)
Krain Creek
N
1 Mile
5 000 Feet
Scale 1:15 840
270 000 FEET
193 000 FEET


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 135)
R. 32 W.
water
(Joins sheet 149)
(Joins sheet 151)
T. 123 N.
(Joins sheet 165)
16
15
14
13
21
22
23
24


(Joins sheet 136)
R. 31 W.
T. 123 N.
(Joins sheet 150)
(Joins sheet 152)
(Joins sheet 166)
18
17
16
19
20
21
Roschein
Lake
Kolling Creek
Kolling Creek
N
1 Mile
5 000 Feet
Scale 1:15 840

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 152

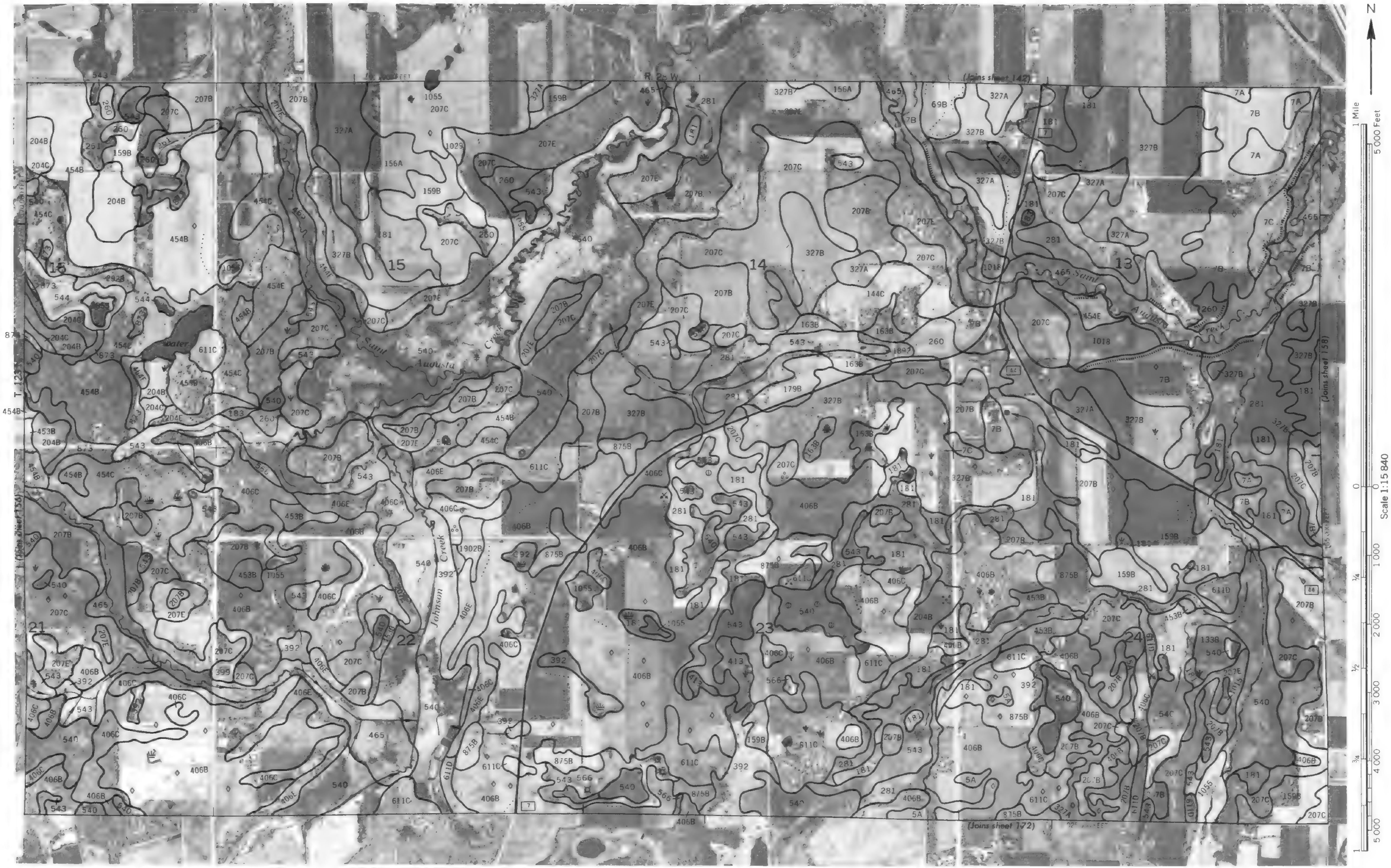


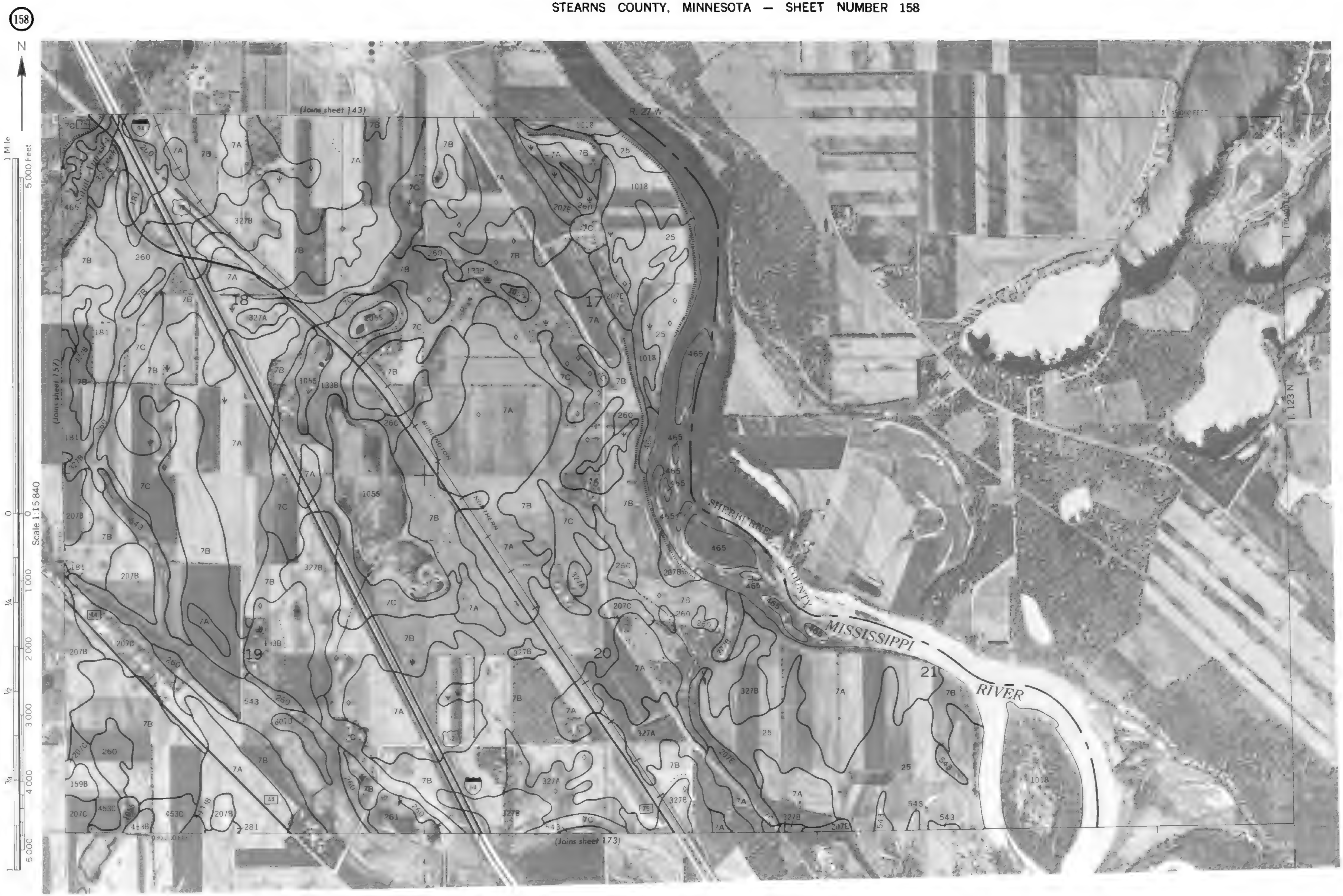

R. 30 W.
(Joins sheet 138)
(Joins sheet 154)
(Joins sheet 168)
(Joins sheet 152)
T. 123 N.
SAINT BONIFACE CEMETERY
COLD SPRING
BURLINGTON NORTHERN
Schneider Lake
Great Northern Lake
SAUK RIVER
water
N
1 Mile
5 000 Feet
Scale 1:15 840

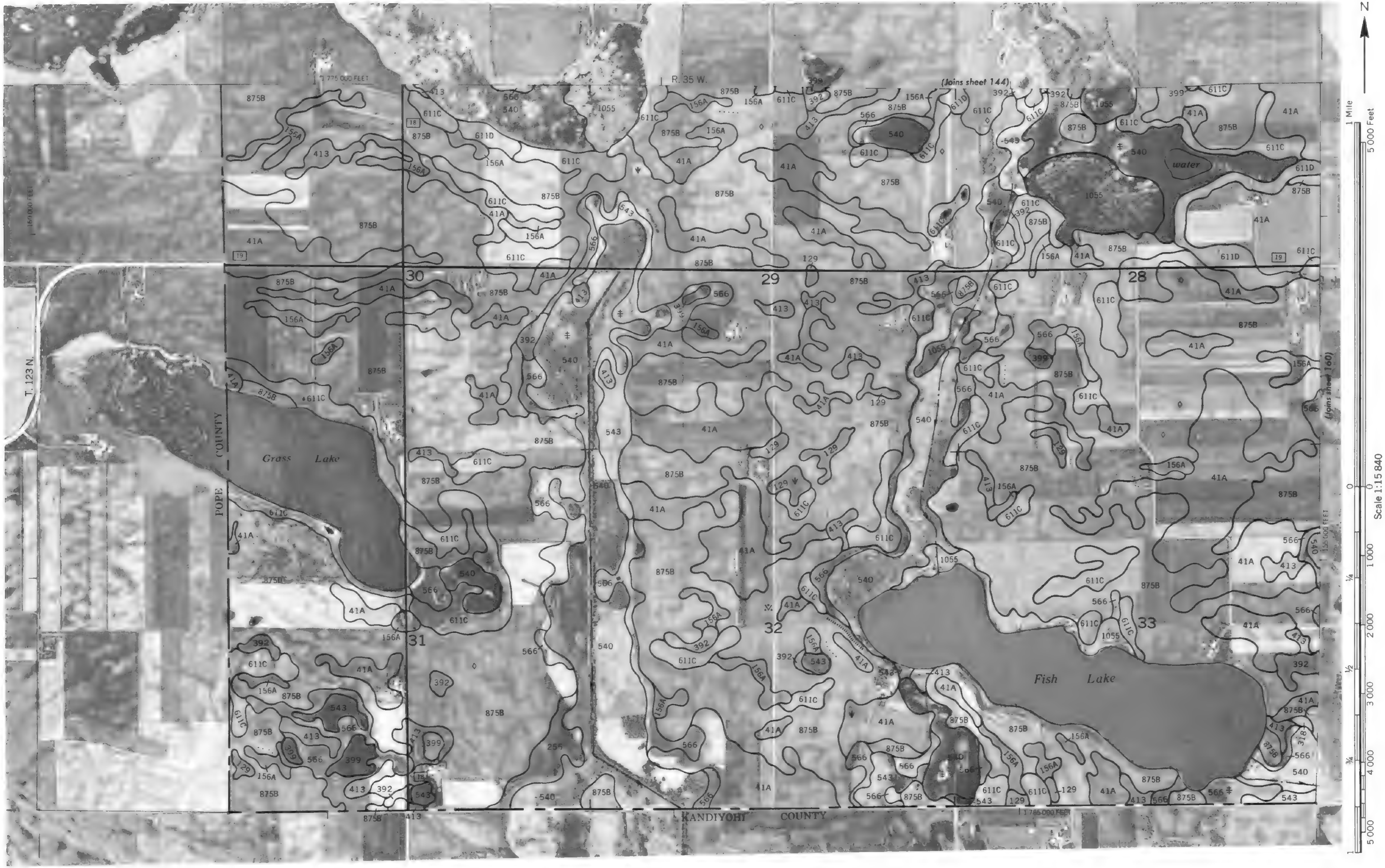

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 139)
(Joins sheet 169)
(Joins sheet 153)
(Joins sheet 155)
R. 30 W.
R. 29 W.
T. 123 N.
SAUK RIVER
BURLINGTON NORTHERN
COLD SPRING
Buer Lake
water


(Joins sheet 140)
R. 29 W.
T. 123 N.
(Joins sheet 154)
(Joins sheet 156)
(Joins sheet 170)
Rockville
SAUK RIVER
BURLINGTON NORTHERN
Mill Creek
Grand Lake
water
16
15
14
17
20
21
22
23
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000


N
(Joins sheet 141)
R. 29 W.
R. 28 W.
(Joins sheet 155)
(Joins sheet 157)
(Joins sheet 171)
T. 123 N.
Luxemberg
13
18
17
16
24
19
20
21
1 Mile
5 000 Feet
Scale 1:15 840
2 010 000 FEET

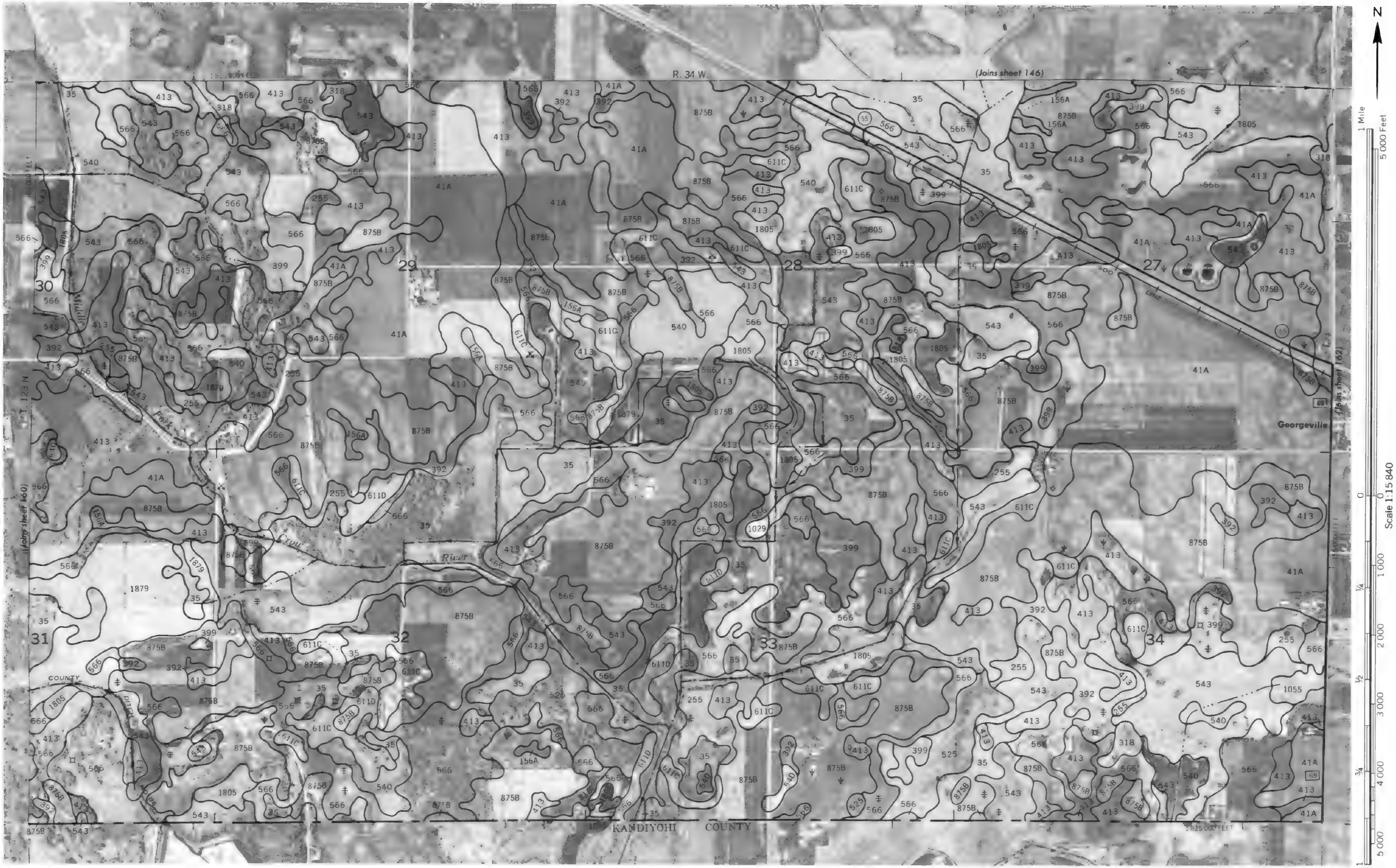

N
(Joins sheet 142)
(Joins sheet 158)
(Joins sheet 172)
(Joins sheet 156)
R. 29 W.
T. 123 N.
Saint Augusta Creek
Johnson Creek
Water
15
14
13
16
21
22
23
24
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾
1


158
N
(Joins sheet 143)
(Joins sheet 157)
(Joins sheet 173)
R. 27 W.
T. 123 N.
MISSISSIPPI
RIVER
SHERBURNE COUNTY
BURLINGTON NORTHERN
Scale 1:15 840
1 Mile
5 000 Feet
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000
17
18
19
20
21

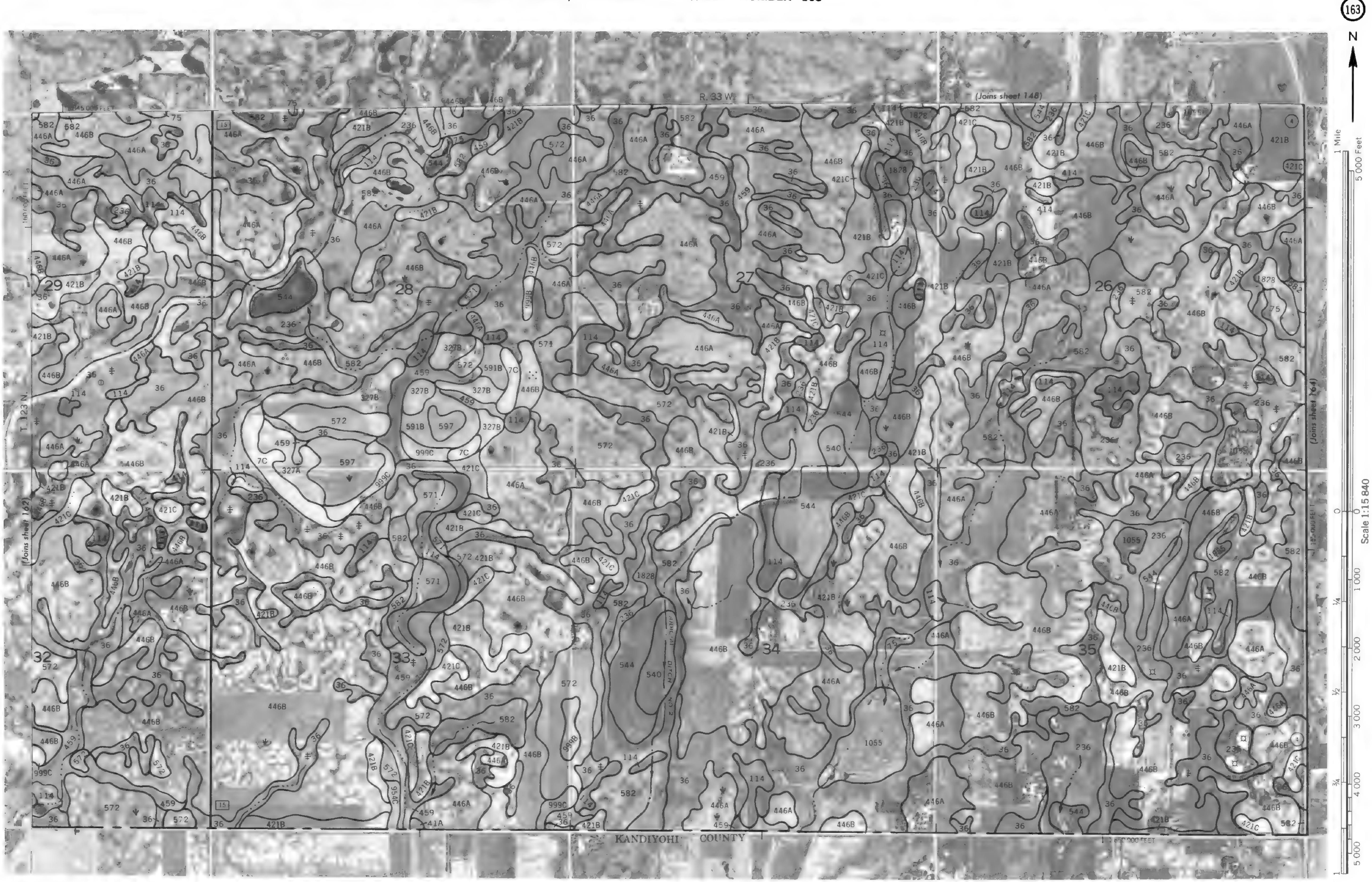

(Joins sheet 144)
R. 35 W.
T. 123 N.
1 775 000 FEET
160 000 FEET
(Joins sheet 160)
155 000 FEET
1 785 000 FEET
POPE COUNTY
KANDIYOHI COUNTY
Grass Lake
Fish Lake
water
30
29
28
31
32
33
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 5)
R. 30 W.
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 29)
T. 126 N.
South Branch Two River
LINE
HIGHLAND CEMETERY
Holdingford


N
1 Mile
5 000 Feet
0
Scale 1:15 840
1 000
2 000
3 000
4 000
5 000
(Joins sheet 145)
(Joins sheet 159)
(Joins sheet 161)
R. 35 W. | R. 34 W.
T. 123 N.
Crow Lake
CROW LAKE CEMETERY
COUNTY DITCH NO 86
KANDIYOHI COUNTY
27
26
25
30
34
35
36
31


N
R. 34 W.
(Joins sheet 146)
(Joins sheet 162)
(Joins sheet 160)
T. 123 N.
Georgeville
KANDIYOHI COUNTY
Crow
River
Middle
Fork
COUNTY
DITCH
27
28
29
30
31
32
33
34
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 147)
R. 34 W
R. 33 W
(Joins sheet 161)
Georgeville
(Joins sheet 163)
T. 123 N.
NORTH FORK CROW RIVER
KANDIYOHI COUNTY
25
26
29
30
31
32
35
36


163
N
R. 33 W.
(Joins sheet 148)
(Joins sheet 162)
(Joins sheet 164)
T. 123 N.
29
28
27
26
32
33
34
35
KANDIYOHI COUNTY
DITCH NO. 2
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 149)
R. 33 W.
R. 32 W.
(Joins sheet 163)
(Joins sheet 165)
(Joins sheet 174)
T. 123 N.
KANDIYOHI COUNTY
COUNTY DITCH NO 5
25
30
29
28
36
31
32
33


165
N
R. 32 W.
T. 123 N.
(Joins sheet 150)
(Joins sheet 164)
(Joins sheet 166)
(Joins sheet 175)
27
28
26
25
33
34
35
36
Roscoe
BURLINGTON
NORTHERN
1 Mile
5 000 Feet
Scale 1:15 840

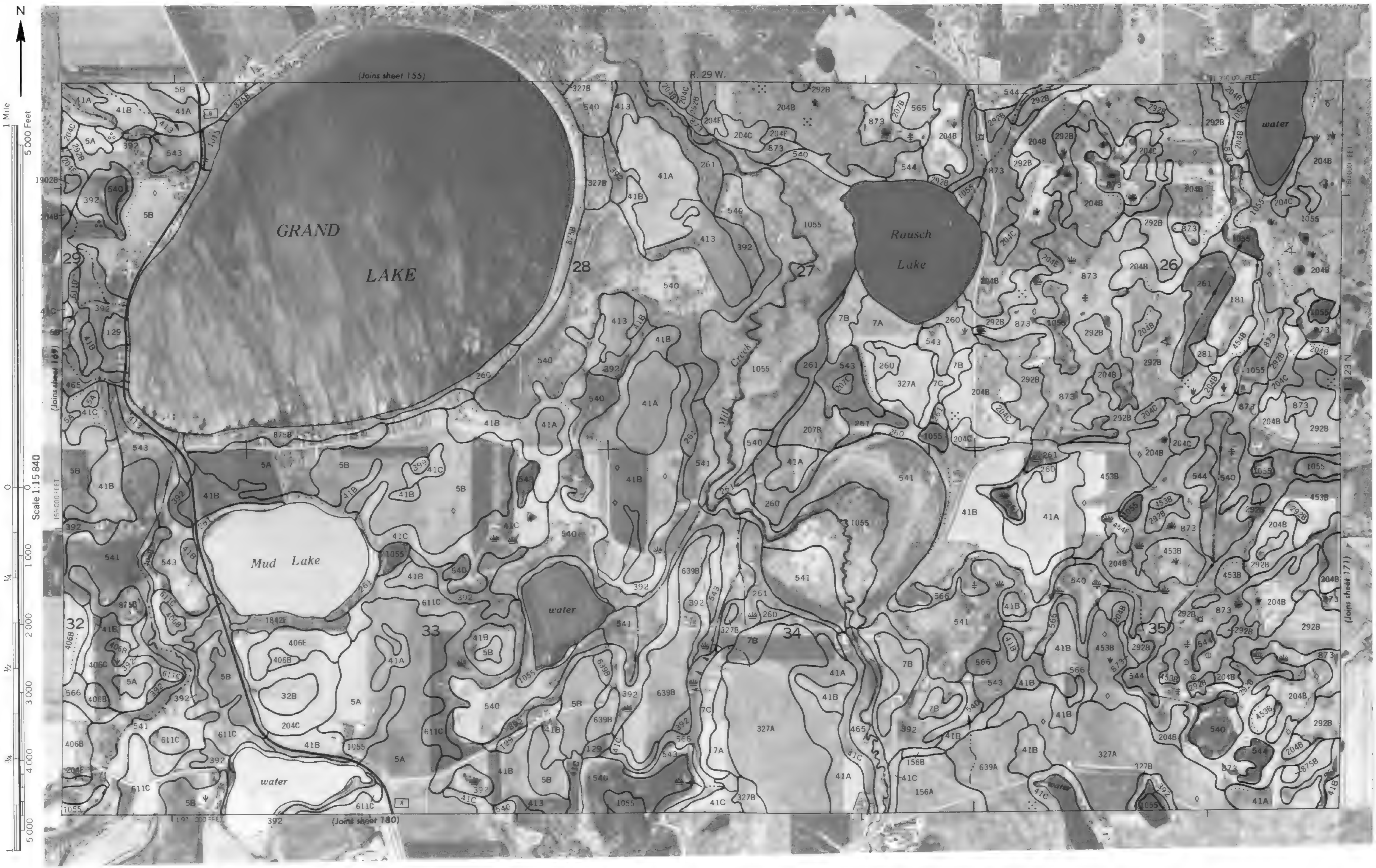
STEARNS COUNTY, MINNESOTA — SHEET NUMBER 166

(Joins sheet 152)
R. 31 W. | R. 30 W.
T. 123 N.
(Joins sheet 166)
(Joins sheet 168)
(Joins sheet 177)
Schroeder Lake
Becker Lake
Big Lake
HORSESHOE LAKE
EAST LAKE
Koetter Lake
KRONS BAY
Cedar Island Lake
Mud Lake
26
27
25
30
34
35
36
31
1 935 000 FEET
N
Scale 1:15 840
1 Mile
5 000 Feet

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 168


Byer Lake
R. 30 W.
R. 29 W.
(Joins sheet 154)
(Joins sheet 170)
(Joins sheet 179)
(Joins sheet 168)
T. 123 N.
25
26
29
30
31
32
35
36
N
1 Mile
5 000 Feet
Scale 1:15 840


R 30 W.
R 29 W.
(Joins inset, sheet 6)
(Joins sheet 18)
(Joins sheet 16)
(Joins sheet 30)
T. 126 N.
Opole
MOUNT CARMEL CEMETERY
Spunk Creek
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 155)
(Joins sheet 169)
(Joins sheet 171)
(Joins sheet 180)
R. 29 W.
T. 123 N.
GRAND LAKE
Rausch Lake
Mud Lake
Mill Creek
water
26
27
28
29
32
33
34
35


N
R. 29 W.
R. 28 W.
1 995 000 FEET
(Joins sheet 156)
(Joins sheet 172)
(Joins sheet 181)
(Joins sheet 170)
T. 123 N.
25
30
29
28
36
31
32
33
water
Beaver Lake
1 010 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 157)
R. 28 W.
(Joins sheet 171)
(Joins sheet 173)
(Joins sheet 182)
T. 123 N.
Johnson Creek
Plum Creek
water
27
28
26
25
33
34
35
36


(Joins sheet 158)
R. 27 W.
T. 123 N.
(Joins sheet 172)
(Joins sheet 183)
(Joins inset, sheet 86)
SHERBURNE COUNTY
MISSISSIPPI RIVER
BURLINGTON NORTHERN
Plum Creek
Bunt Lake
Warner Lake
Fuller Lake
water
ACACIA CEMETERY
2 045 000 FEET
27
28
29
30
31
32
33
34
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4
1

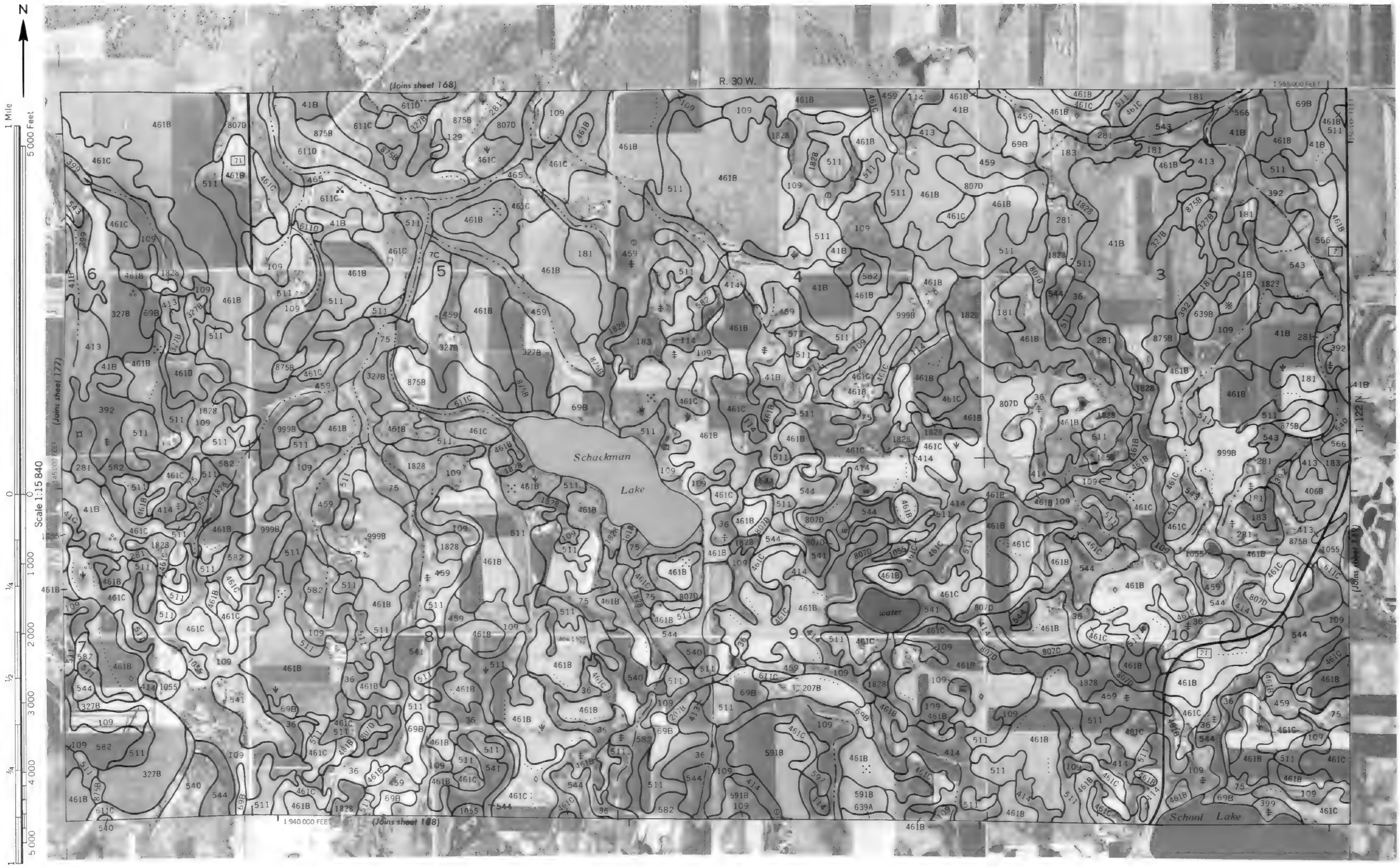
STEARNS COUNTY, MINNESOTA — SHEET NUMBER 174

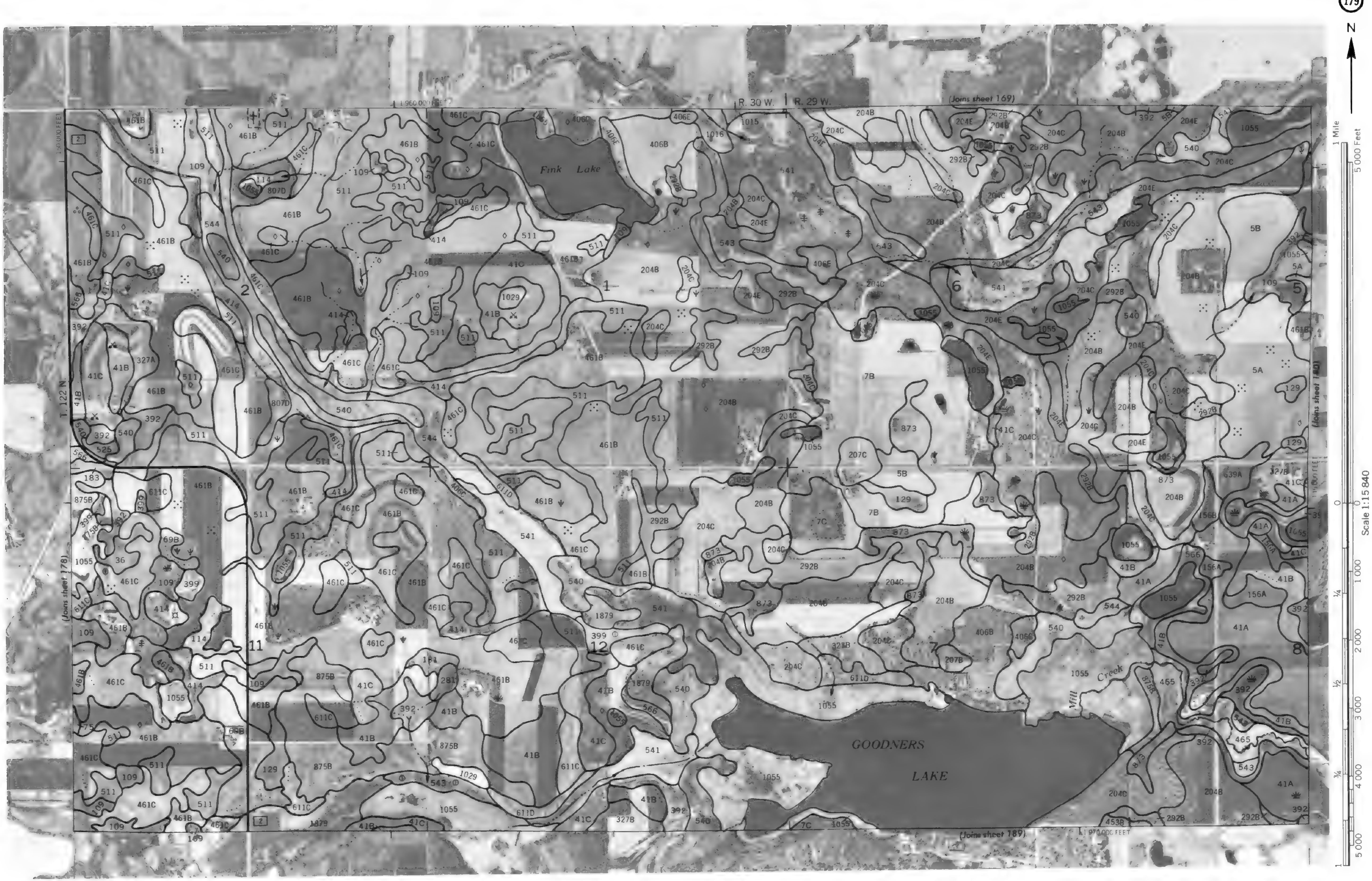
STEARNS COUNTY, MINNESOTA — SHEET NUMBER 175

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 176

177

N
(Joins sheet 167)
R. 31 W. | R. 30 W.
Meyers Lake
Ganzer Lake
Flint Lake
Deep Lake
water
LONG LAKE
NORTH BROWNS LAKE
T. 122 N.
(Joins sheet 176)
(Joins sheet 178)
(Joins sheet 187)
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 168)
R. 30 W.
(Joins sheet 177)
T. 122 N.
Schackman Lake
water
School Lake
1 940 000 FEET
(Joins sheet 188)

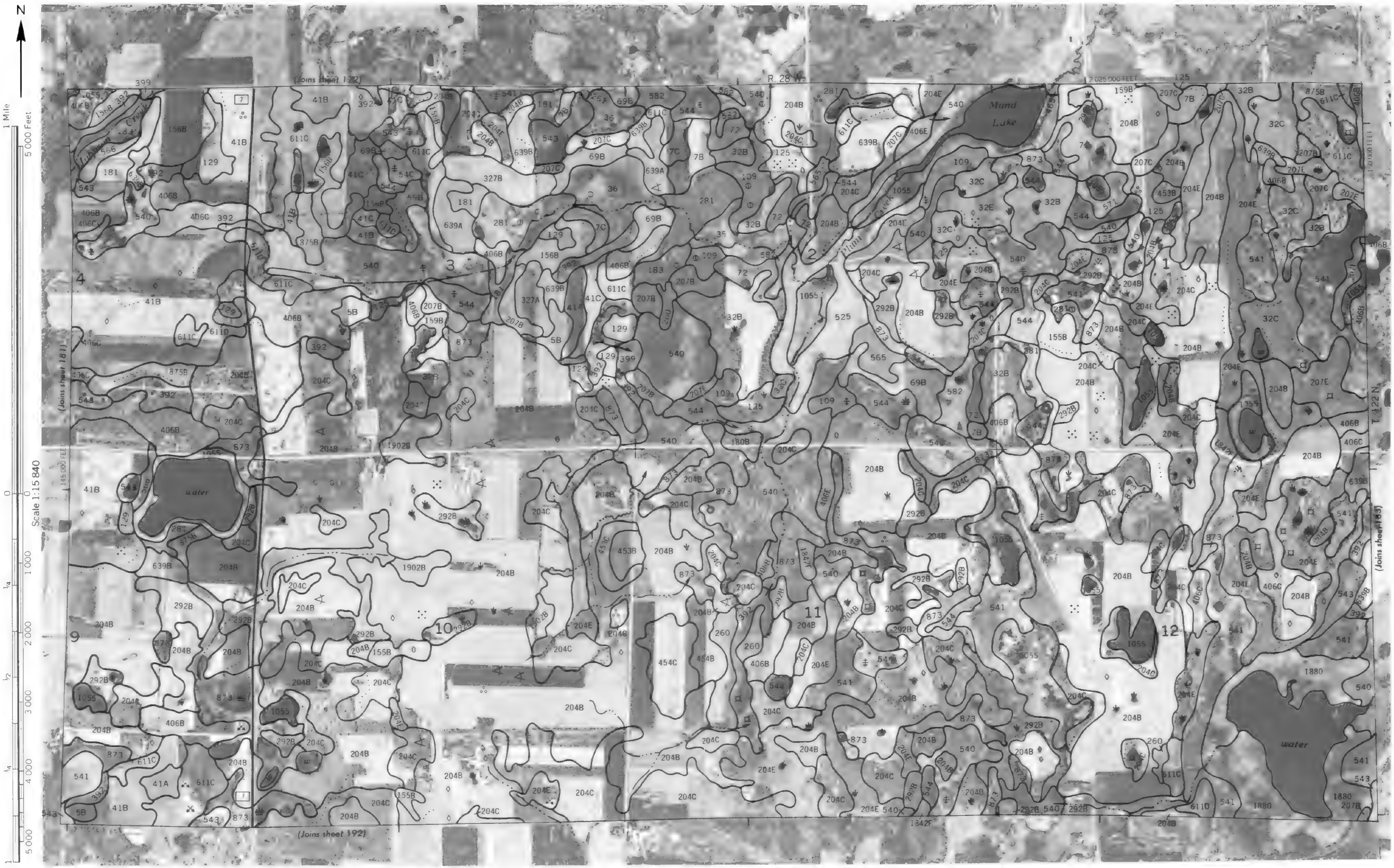


(Joins sheet 169)
R. 30 W.
R. 29 W.
1 960 000 FEET
Fink Lake
T. 122 N.
(Joins sheet 178)
(Joins sheet 180)
GOODNERS
LAKE
Mill Creek
(Joins sheet 189)
1 970 000 FEET
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 6)
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 31)
R. 29 W.
T. 126 N.
1 990 000 FEET
1 975 000 FEET
Spunk Creek
Stony Creek
Stony Creek


N
(Joins sheet 170)
(Joins sheet 179)
(Joins sheet 181)
(Joins sheet 190)
R. 29 W.
T. 122 N.
PEARL LAKE
Mill Creek
Scale 1:15 840
1 Mile
5 000 Feet
1 990 000 FEET
1 975 000 FEET


(Joins sheet 171)
(Joins sheet 182)
(Joins sheet 191)
(Joins sheet 180)
R. 29 W.
R. 28 W.
T. 122 N.
Beaver Lake
Johnson Creek
MAINE PRAIRIE CEMETERY
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 172)
(Joins sheet 181)
(Joins sheet 183)
(Joins sheet 192)
R. 28 W.
T. 122 N.
2 025 000 FEET
145 000 FEET
Mund Lake
Plum Creek
water

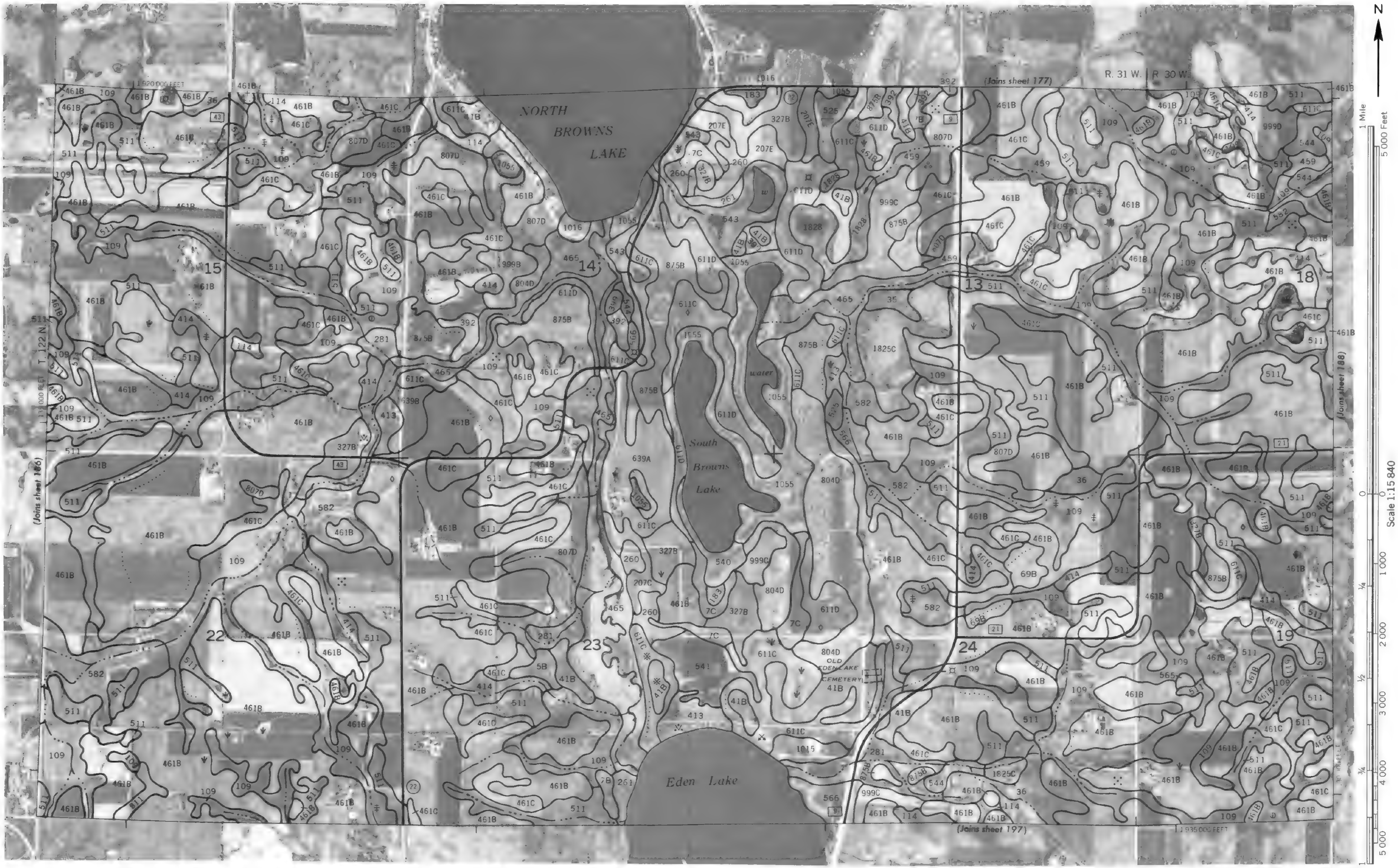

N
R. 27 W.
(Joins sheet 173)
(Joins inset, sheet 86)
(Joins sheet 193)
Dallas Lake
Feldges Lake
Maria Lake
Long Lake
Crooked Lake
Plum Creek
WRIGHT COUNTY
1 Mile
5 000 Feet
Scale 1:15 840

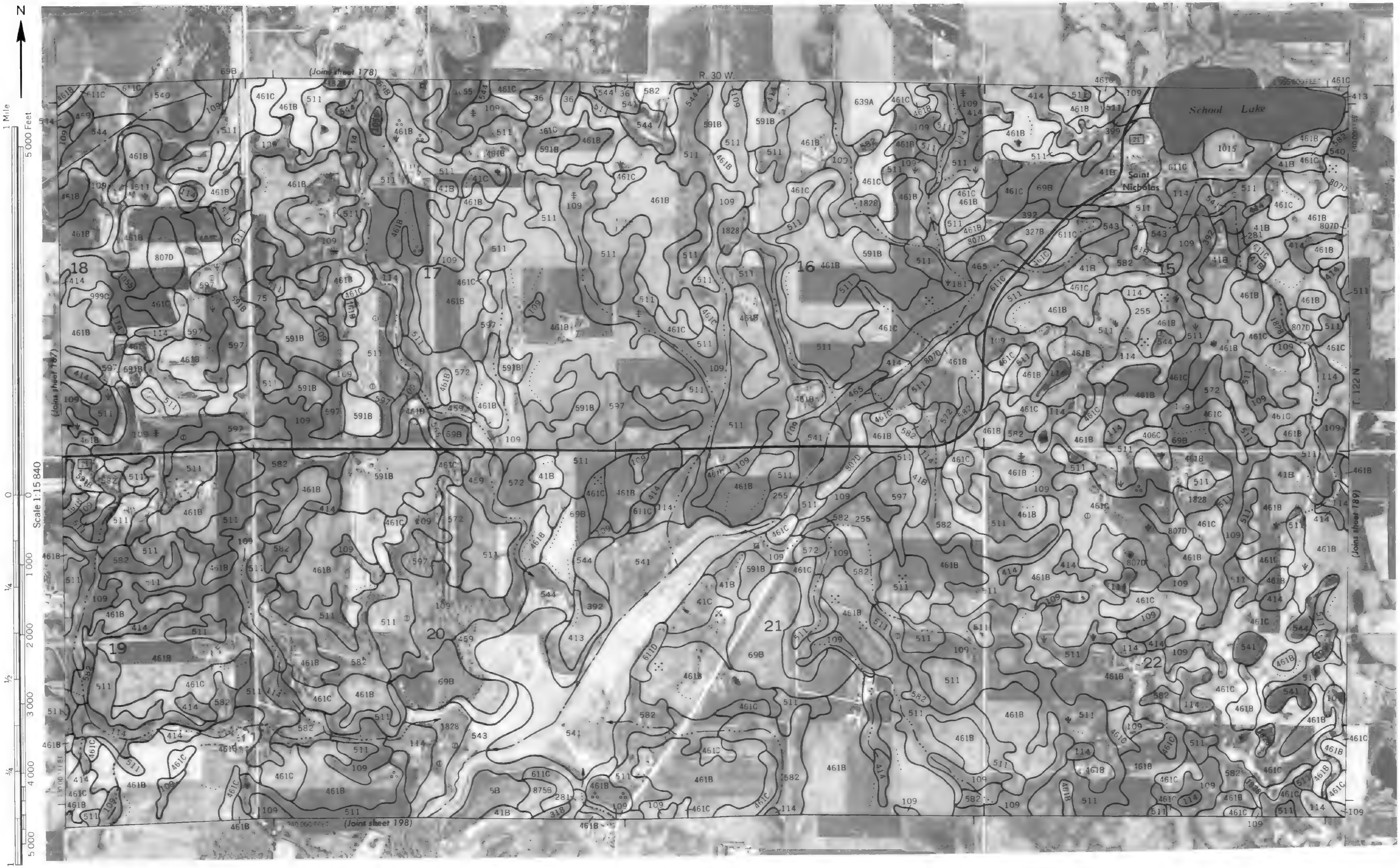

N
Scale 1:15 840
(Joins sheet 174)
R. 32 W.
(Joins sheet 194)
KANDIYOHI COUNTY
NORTH FORK CROW RIVER
PAYNESVILLE
PAYNESVILLE AIRSTRIP
18
17
16
19
20
21

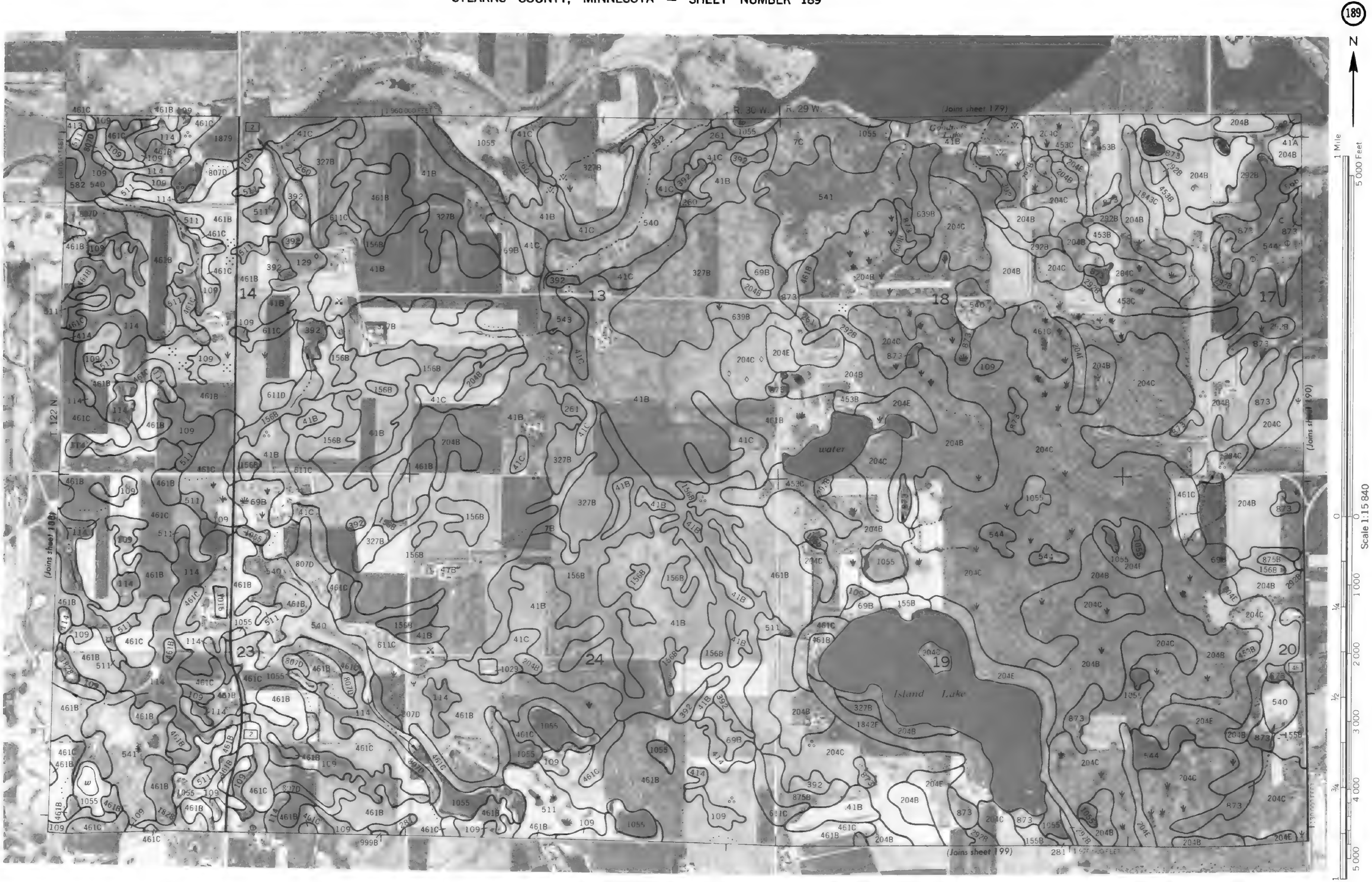

185
N
R. 32 W.
(Joins sheet 175)
(Joins sheet 184)
(Joins sheet 186)
(Joins sheet 195)
T. 122 N.
PAYNESVILLE
PAYNESVILLE SANITARY LANDFILL
NORTH FORK CROW RIVER
Rice Lake
water
16
15
14
13
21
22
23
24
1 Mile
5 000 Feet
Scale 1:15 840
900 000 FEET


N
RICE LAKE
(Joins sheet 176)
(Joins sheet 185)
(Joins sheet 187)
(Joins sheet 196)
R. 31 W.
T. 122 N.
Camp
16
17
18
19
20
21
Scale 1:15 840
1 Mile
5 000 Feet

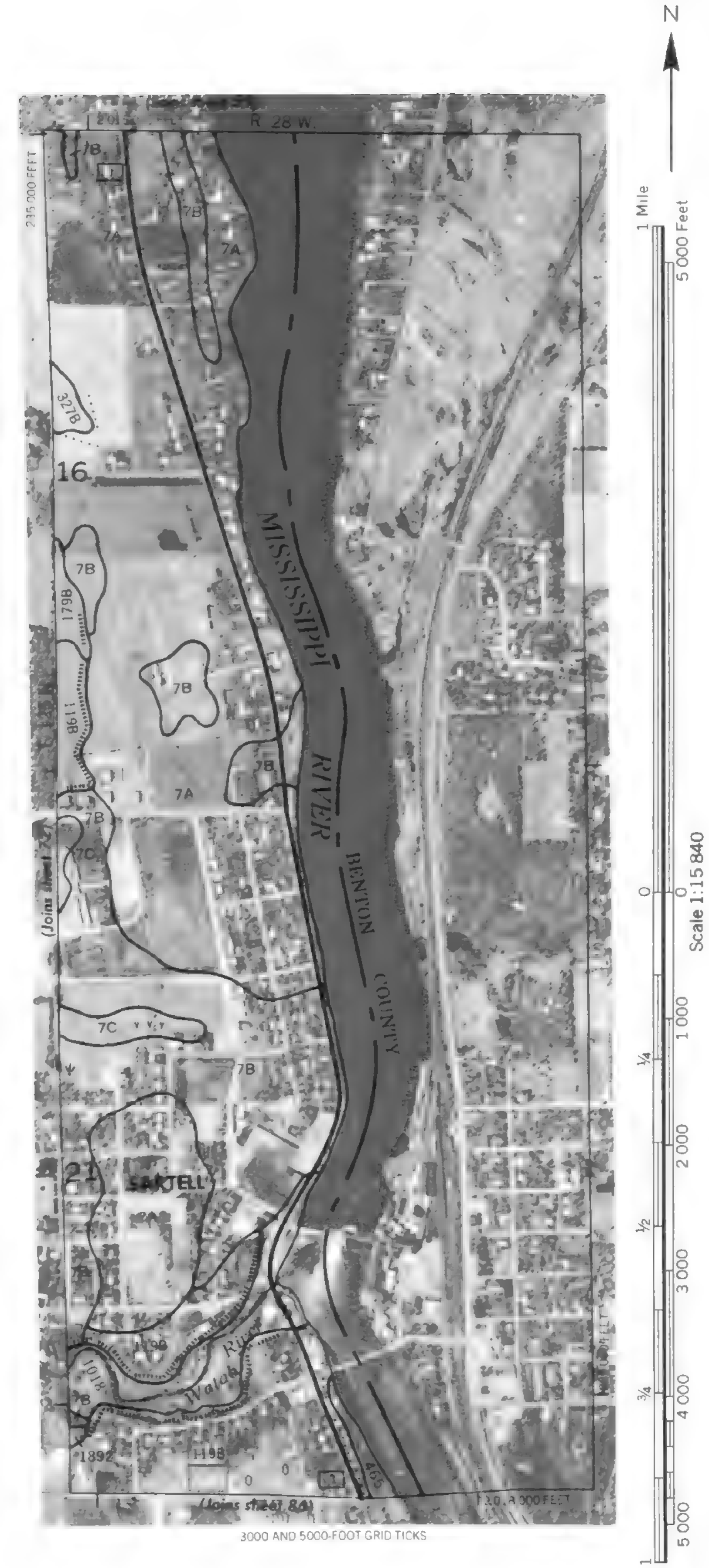
187

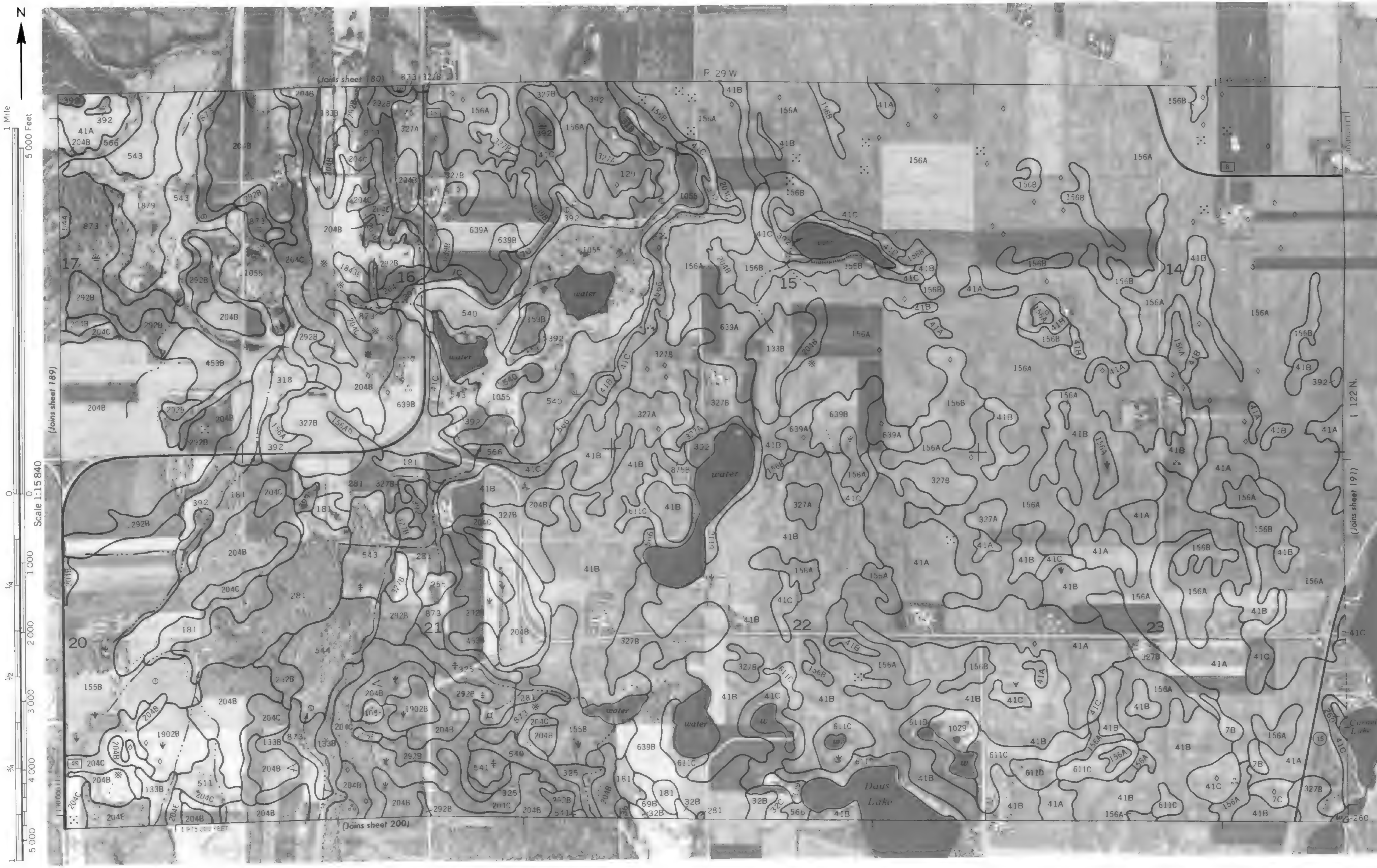

NORTH BROWNS LAKE
South Browns Lake
water
Eden Lake
OLD EDEN LAKE CEMETERY
(Joins sheet 177)
(Joins sheet 188)
(Joins sheet 186)
(Joins sheet 197)
R. 31 W.
R. 30 W.
T. 122 N.
1 920 000 FEET
1 935 000 FEET
15
14
13
18
22
23
24
19
N
1 Mile
5 000 Feet
Scale 1:15 840

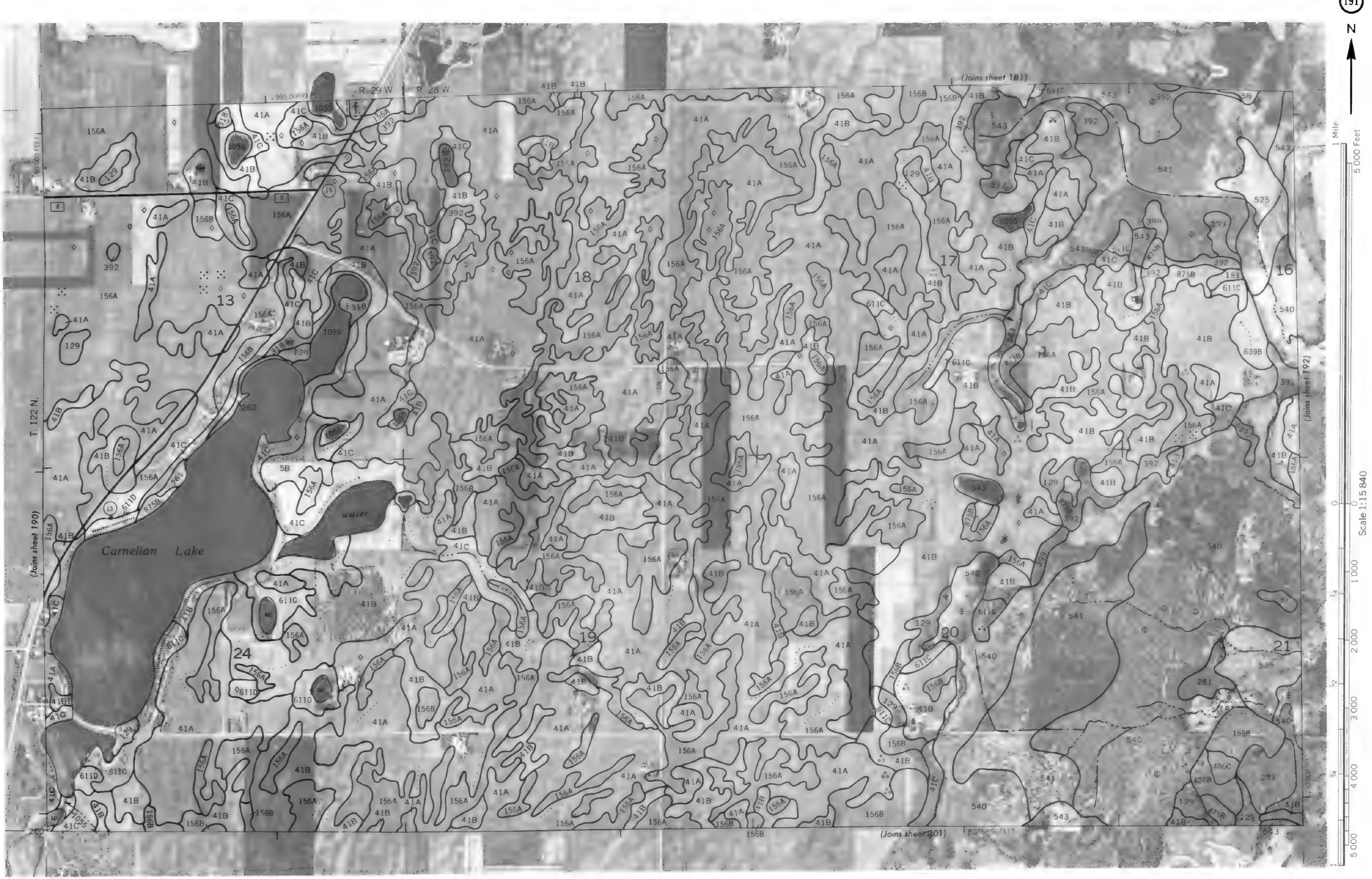

N
(Joins sheet 178)
R. 30 W.
School Lake
Saint Nicholas
T. 122 N
(Joins sheet 187)
(Joins sheet 189)
(Joins sheet 198)
18
17
16
15
19
20
21
22
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000


189
N
(Joins sheet 179)
(Joins sheet 199)
(Joins sheet 190)
(Joins sheet 188)
R. 30 W.
R. 29 W.
T. 122 N.
Island Lake
water
1 Mile
5 000 Feet
Scale 1:15 840

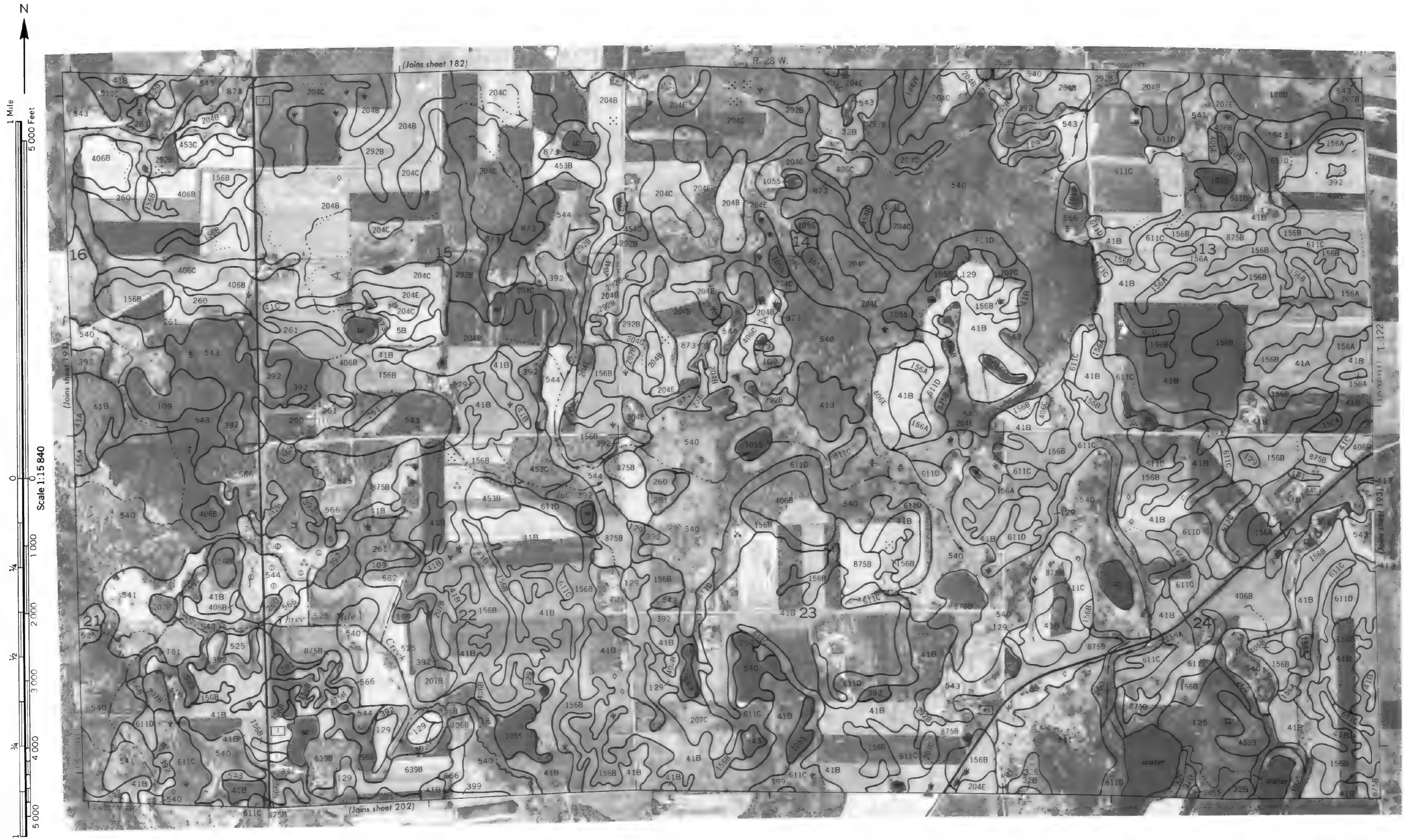

(Joins inset, sheet 59)
R. 29 W.
R. 28 W.
T. 126 N.
MISSISSIPPI RIVER
BENTON COUNTY
MISSISSIPPI RIVER
(Joins sheet 18)
(Joins sheet 32)
1
6
7
12
1018
7B
7A
465
218
179B
7C
119B
144C
454E
1029
144B
260
281
325
1892
142
183
540
163B
144E
261
543
454B


R. 28 W.
16
21
SARTELL
MISSISSIPPI RIVER
BENTON COUNTY
(Joins sheet 84)
3000 AND 5000-FOOT GRID TICKS
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 180)
R. 29 W
T. 122 N.
(Joins sheet 189)
(Joins sheet 191)
(Joins sheet 200)
Daus Lake
water


191
N
(Joins sheet 181)
(Joins sheet 190)
(Joins sheet 192)
(Joins sheet 201)
R. 29 W.
R. 28 W.
T. 122 N.
Carnelian Lake
water
13
16
17
18
19
20
21
24
1 Mile
5 000 Feet
Scale 1:15 840

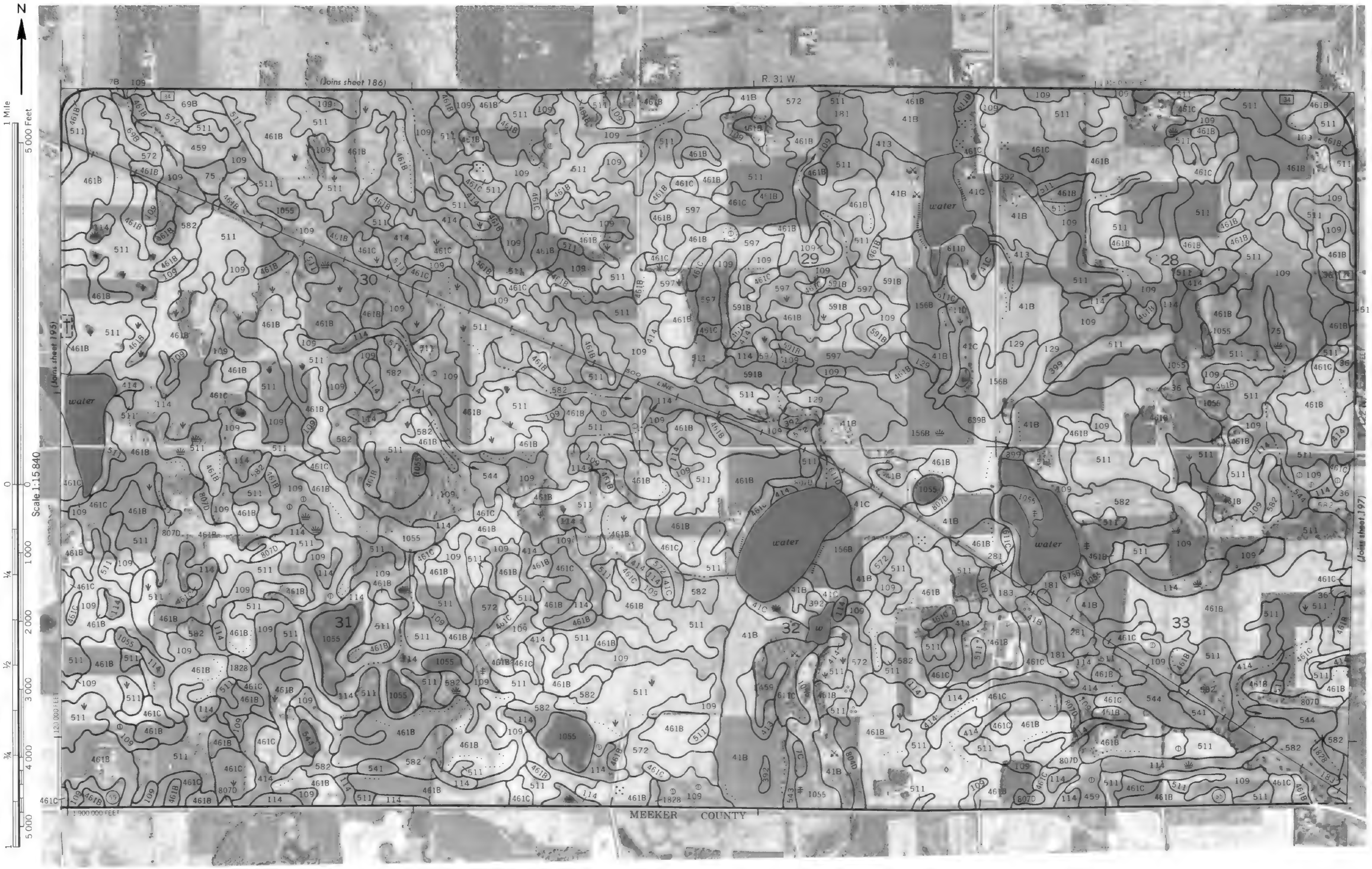
192

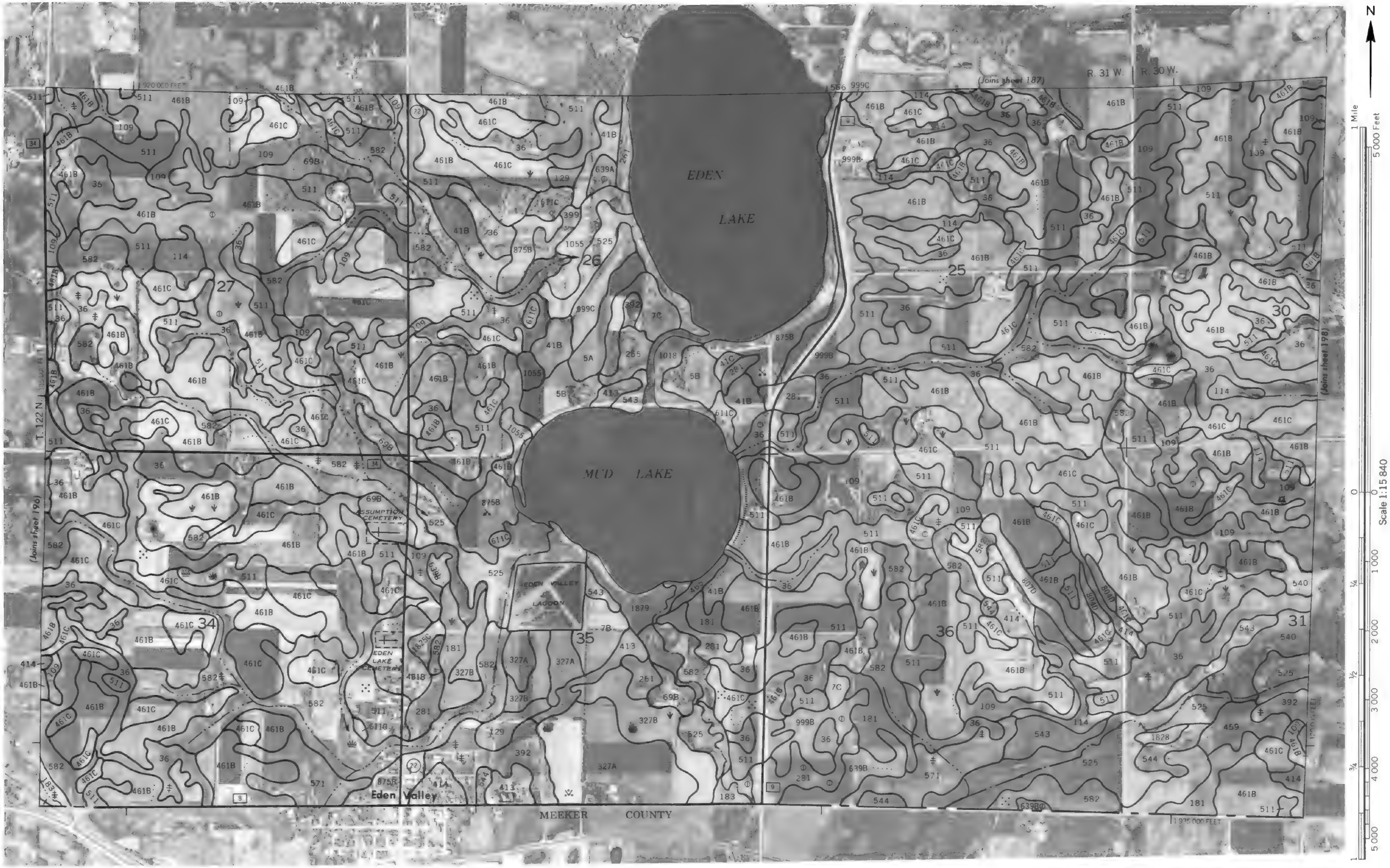

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 182)
R. 28 W.
(Joins sheet 191)
(Joins sheet 193)
(Joins sheet 202)
T. 122
Three Mile Creek
water
16
15
14
13
21
22
23
24


R. 27 W. (Joins sheet 183)
(Joins sheet 192)
(Joins sheet 203)
T. 122 N.
Hinz Lake
Hulbert Lake
Quinn Lake
Clearwater River
WRIGHT COUNTY
2 030 000 FEET
2 045 000 FEET
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 184)
R. 32 W.
KANDIYOHI COUNTY
MEEKER COUNTY
LAKE KORONIS
Second Island
Third Island
Lake Koronis Assembly Ground
28
29
30
31
32
33

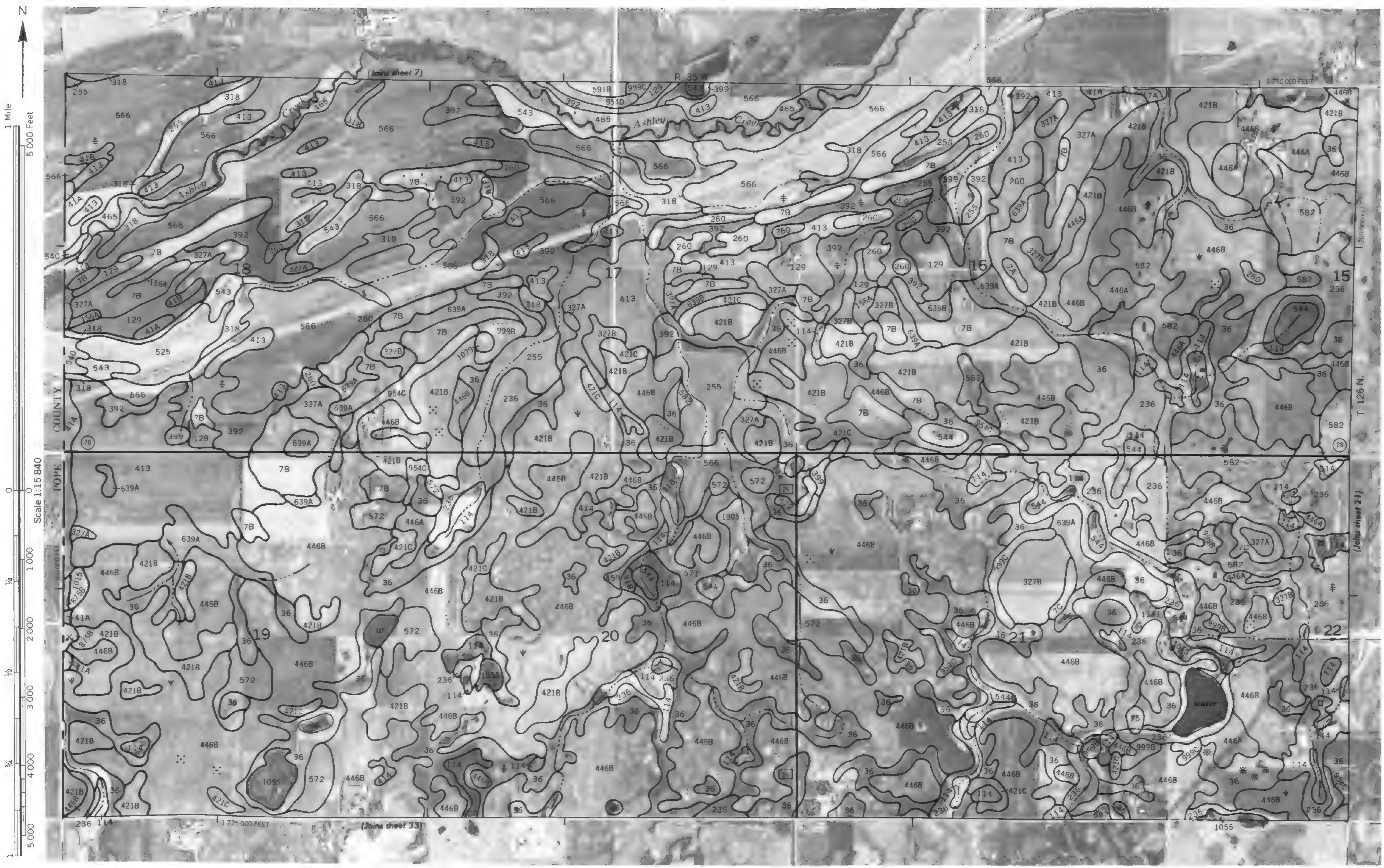

N
R. 32 W.
(Joins sheet 185)
(Joins sheet 194)
(Joins sheet 196)
T. 122 N.
LAKE
KORONIS
First Island
Krueger
Lake
Mud
Lake
NORTH
FORK
CROW
RIVER
MEEKER
COUNTY
25
26
27
28
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 186)
R. 31 W.
(Joins sheet 195)
(Joins sheet 197)
MEEKER COUNTY
30
29
28
31
32
33
water
water
water
water
SOO LINE


EDEN LAKE
MUD LAKE
(Joins sheet 187)
R. 31 W.
R. 30 W.
(Joins sheet 196)
(Joins sheet 198)
T. 122 N.
ASSUMPTION CEMETERY
EDEN VALLEY LAGOON
EDEN LAKE CEMETERY
Eden Valley
MEEKER COUNTY
1 920 000 FEET
1 935 000 FEET
27
26
25
30
34
35
36
31
N
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000

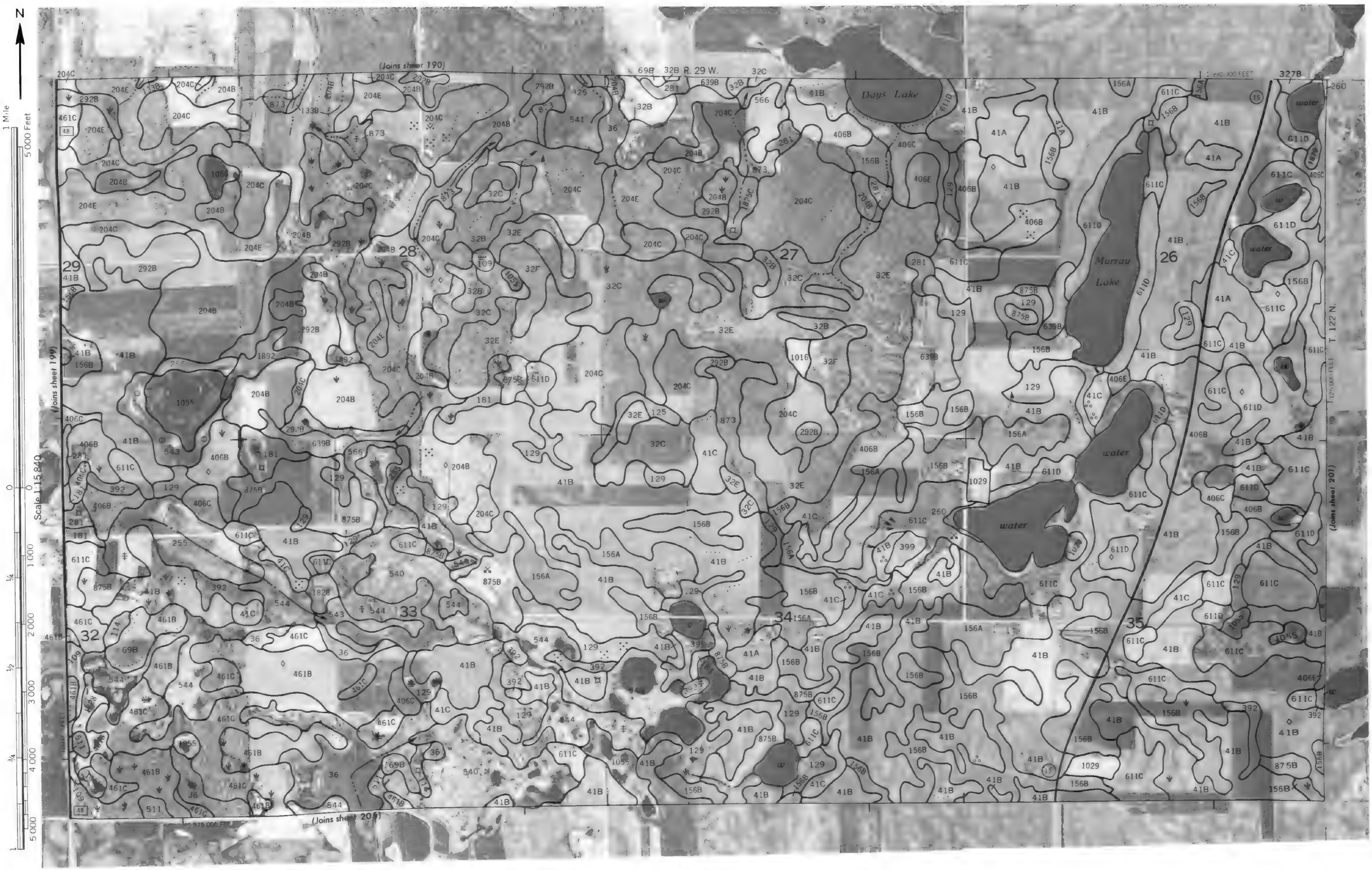

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 188)
R. 30 W.
T. 122 N.
(Joins sheet 197)
(Joins sheet 199)
MEEKER COUNTY
27
28
29
30
31
32
33
34

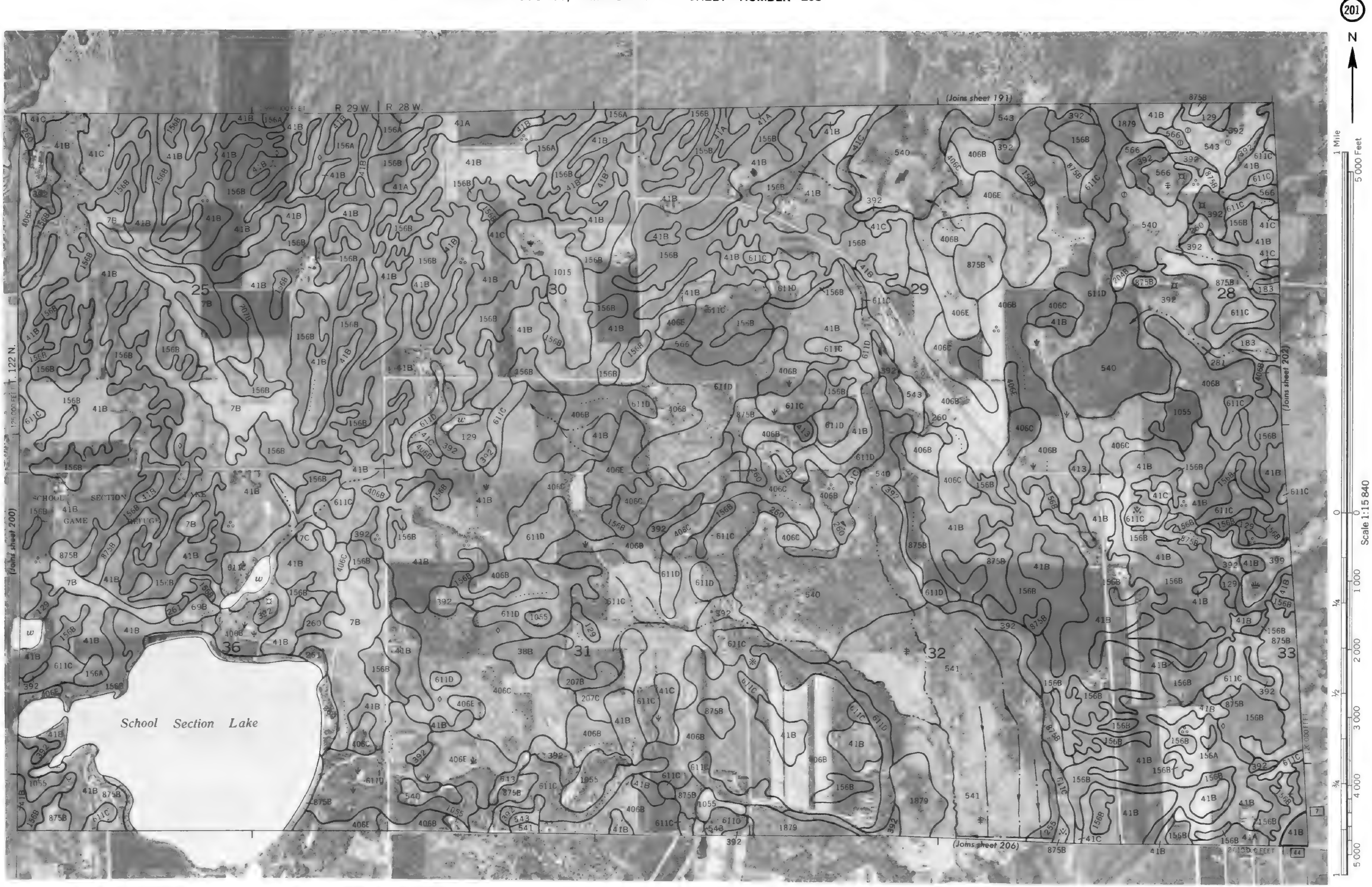

N
R. 30 W.
R. 29 W.
(Joins sheet 189)
(Joins sheet 198)
(Joins sheet 200)
(Joins sheet 204)
T. 122 N.
MEEKER COUNTY
water
Carter Lake
Swamp Lake
26
25
30
29
35
36
31
32
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1
(Joins sheet 7)
R. 35 W.
1 790 000 FEET
Ashley Creek
Ashley
Creek
POPE COUNTY
T. 126 N.
(Joins sheet 21)
(Joins sheet 33)
1 775 000 FEET
18
17
16
15
19
20
21
22
water

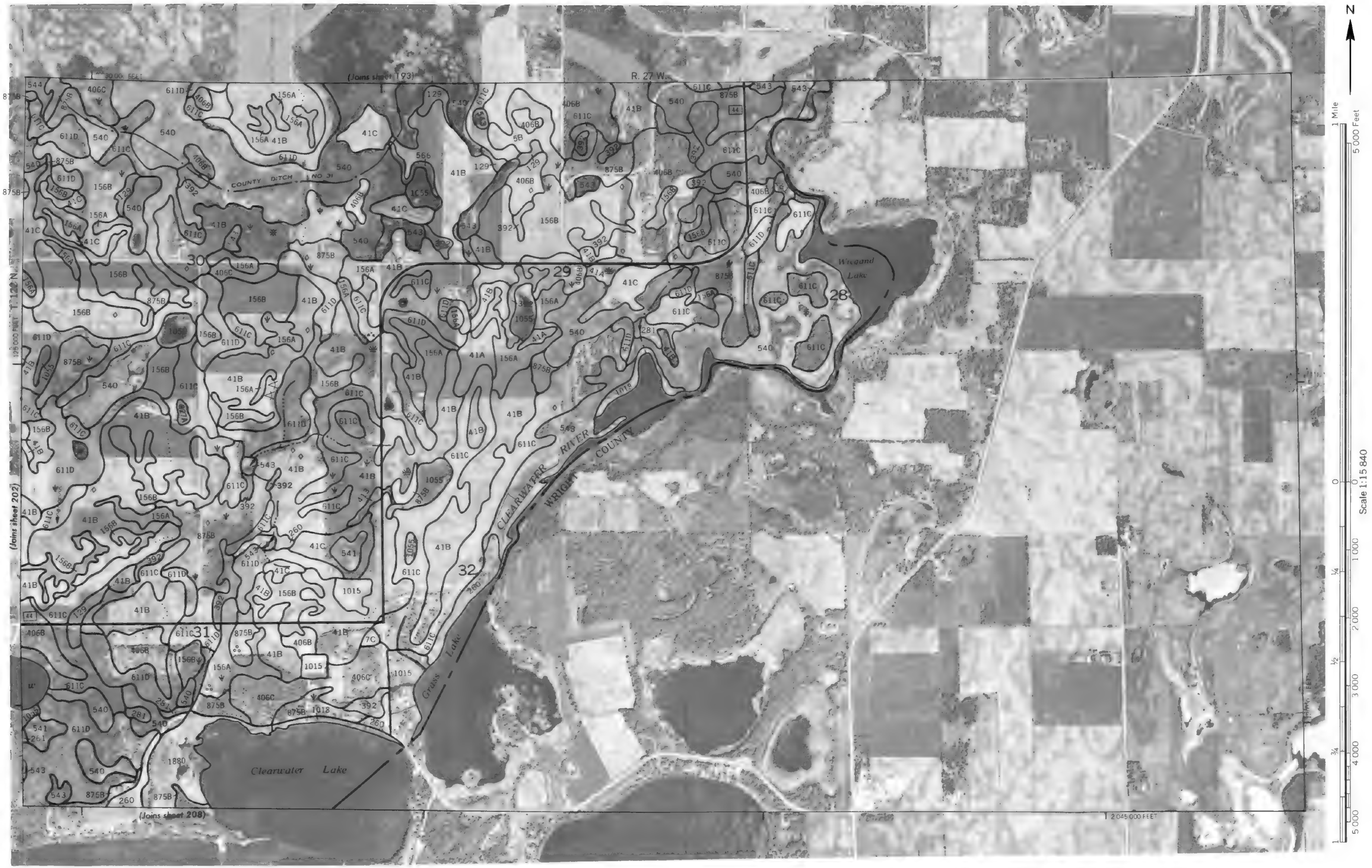
STEARNS COUNTY, MINNESOTA — SHEET NUMBER 200

200

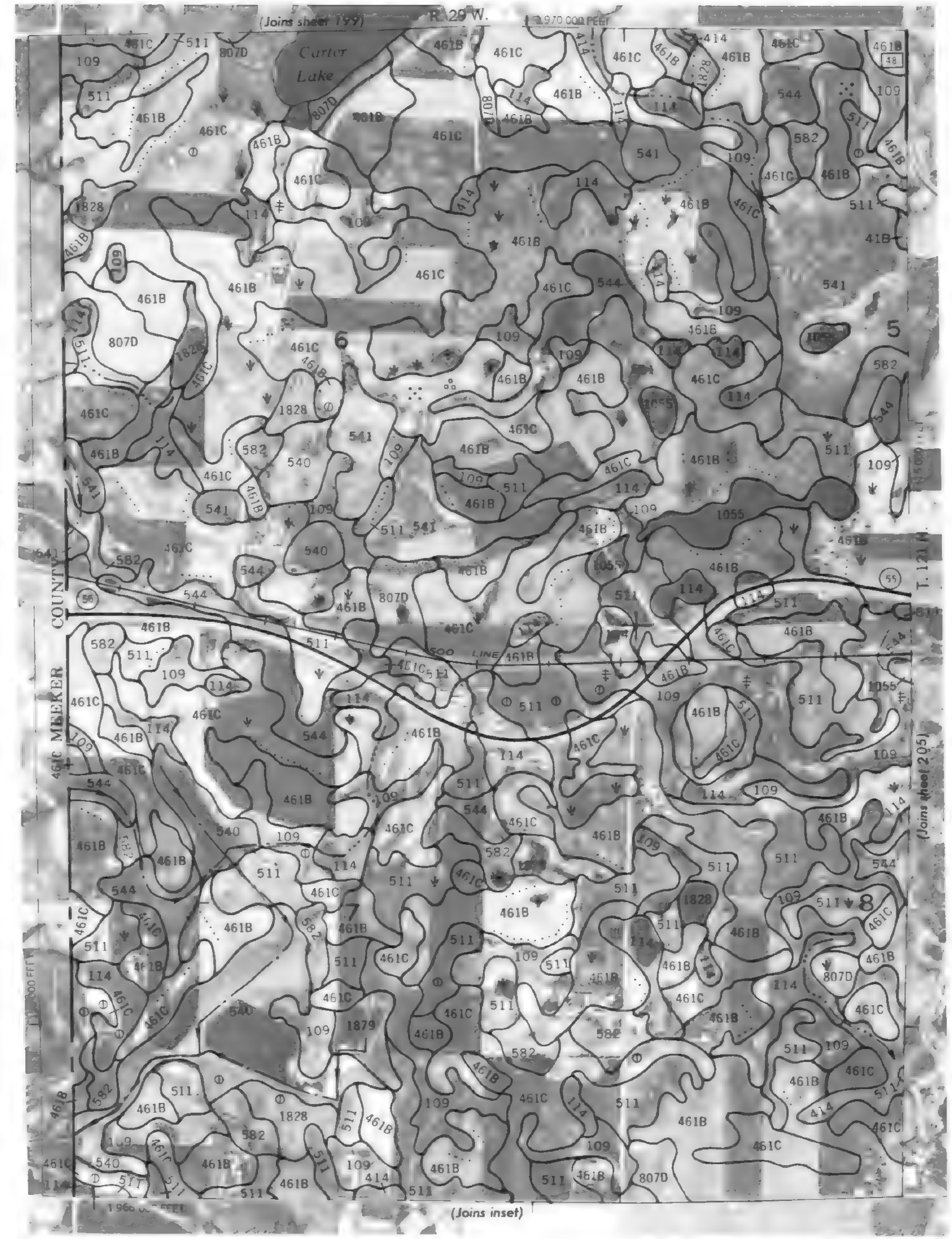



201
N
(Joins sheet 191)
(Joins sheet 202)
(Joins sheet 206)
(Joins sheet 200)
R. 29 W. | R. 28 W.
T. 122 N.
School Section Lake
SCHOOL SECTION LAKE GAME REFUGE
25
30
29
28
36
31
32
33
1 Mile
5 000 Feet
Scale 1:15 840

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 202


N
(Joins sheet 193)
R. 27 W.
T. 122 N.
(Joins sheet 202)
(Joins sheet 208)
COUNTY DITCH NO 31
CLEARWATER RIVER
WRIGHT COUNTY
Wiegand Lake
Grass Lake
Clearwater Lake
30
29
28
32
31
1 Mile
5 000 Feet
Scale 1:15 840
2 045 000 FEET

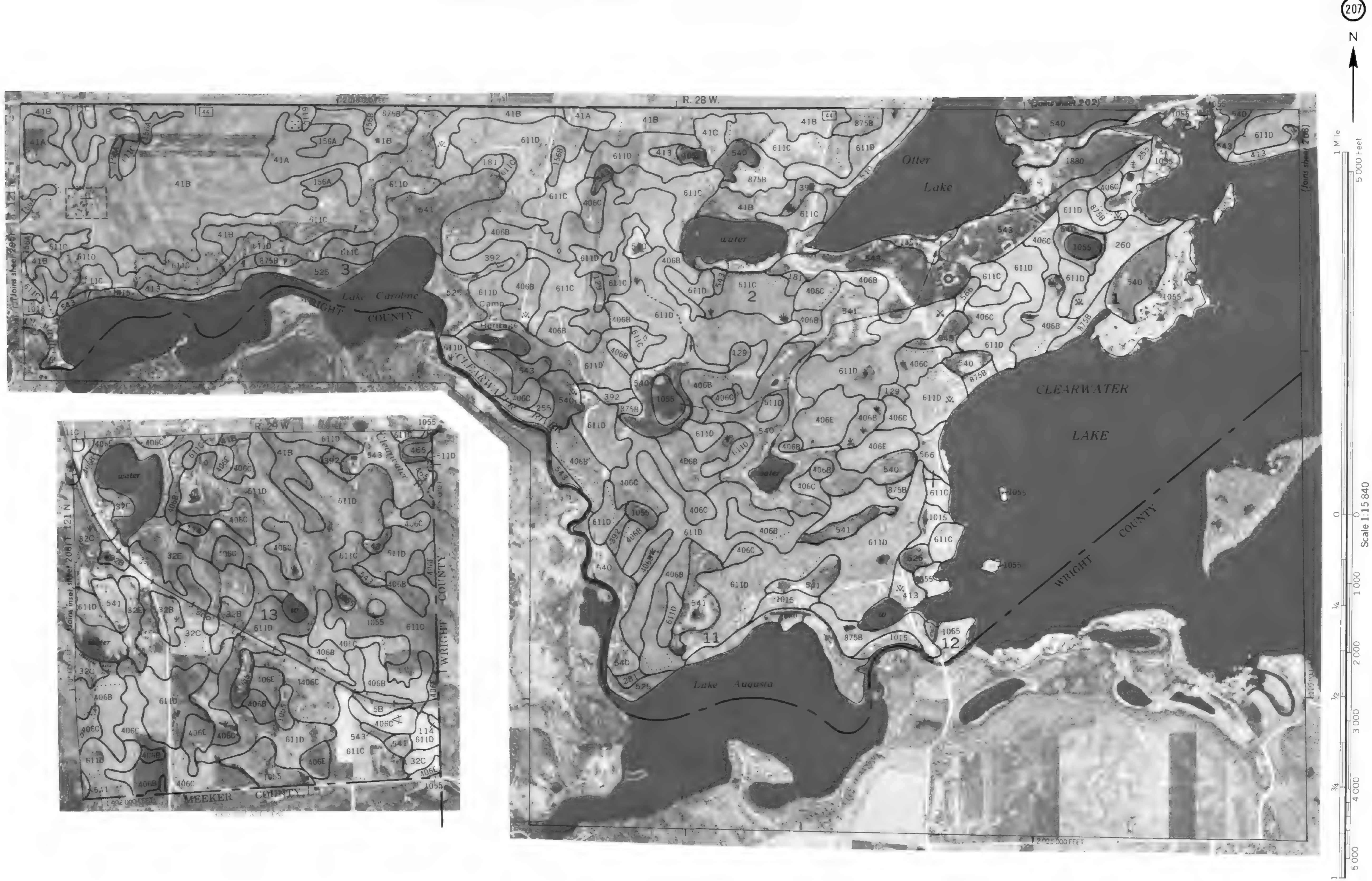
3000 AND 4000-FOOT GRID TICKS



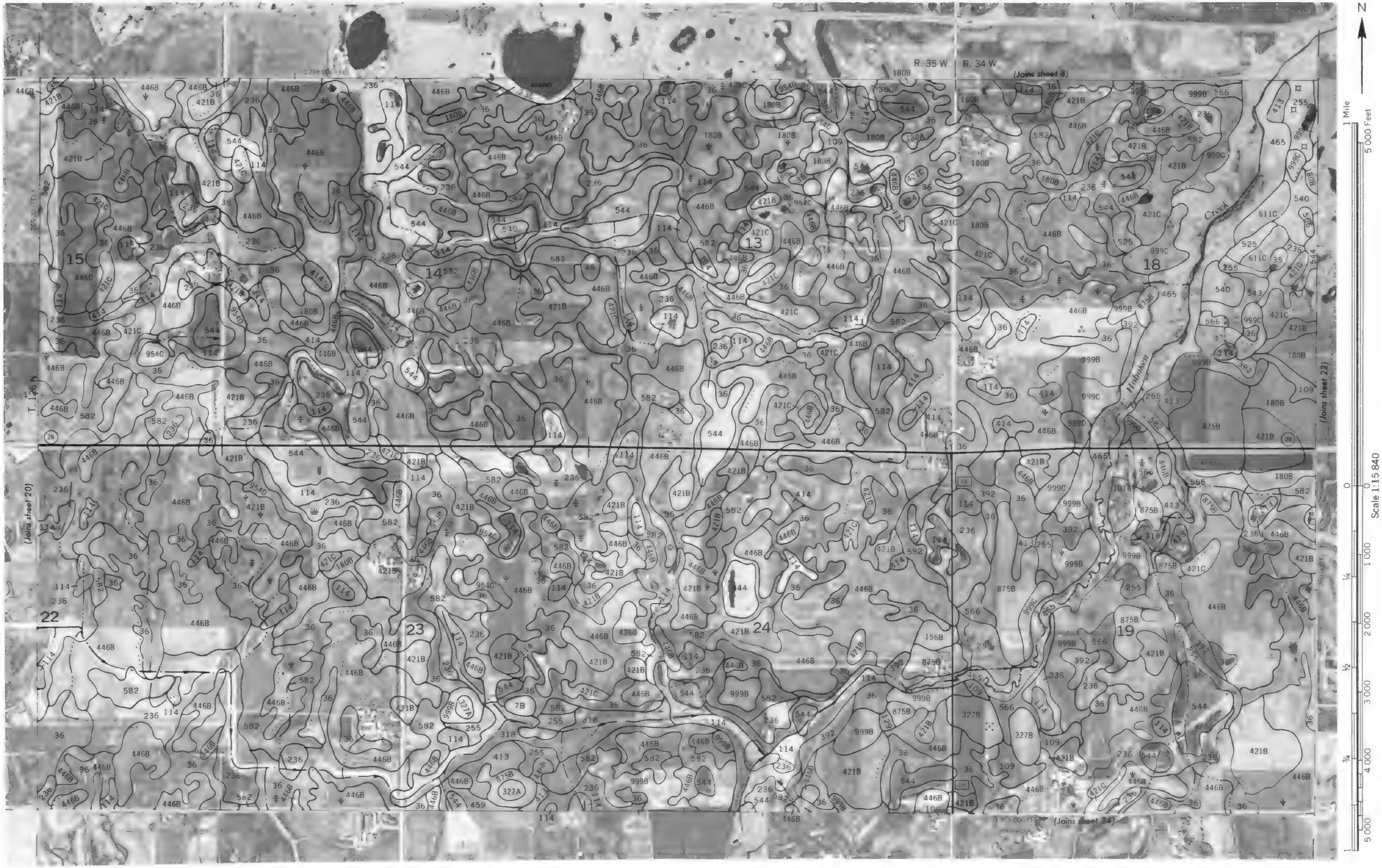
4000 AND 5000-FOOT GRID TICKS

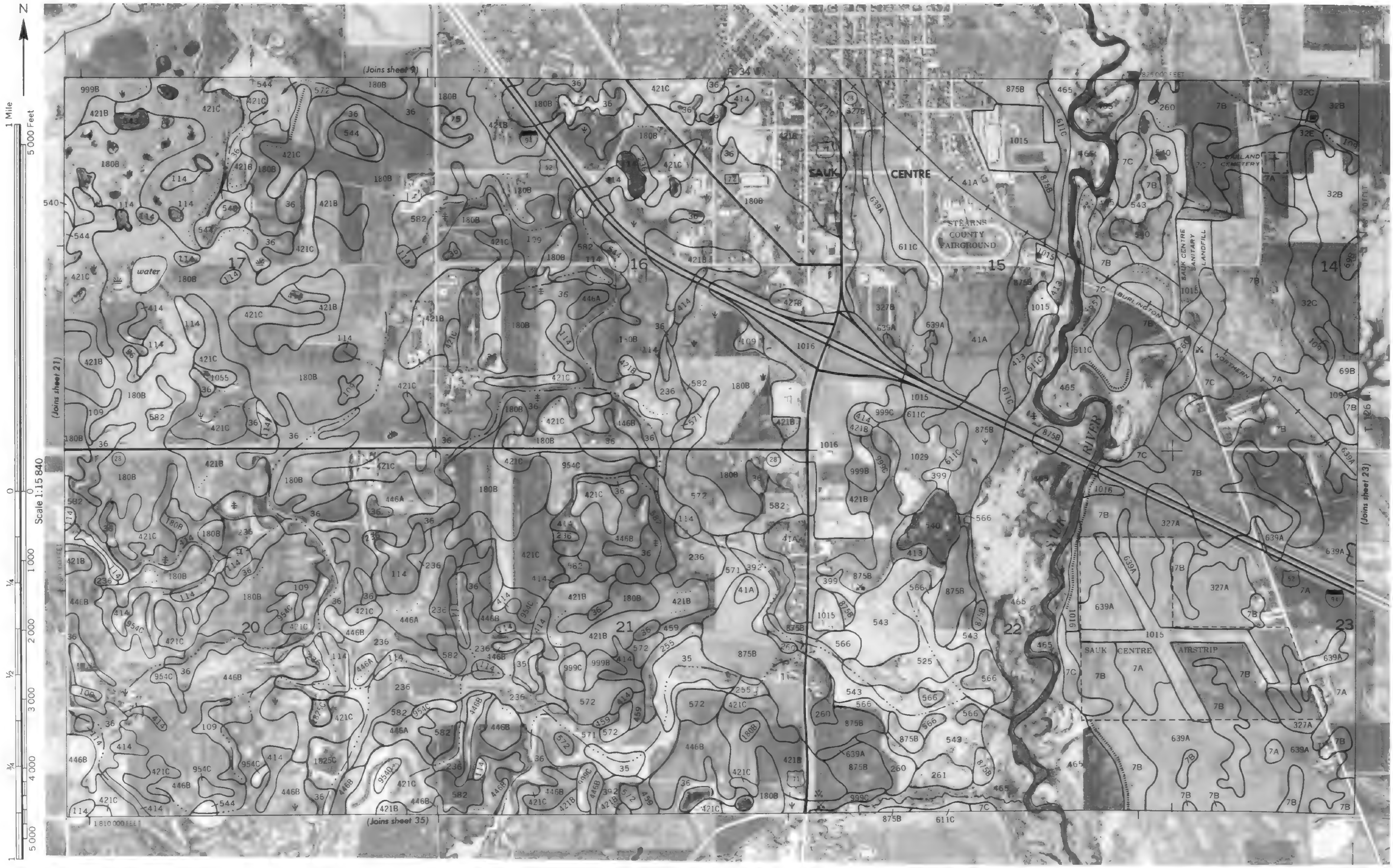

205
N
(Joins sheet 200)
R. 29 W.
T. 121 N.
(Joins sheet 204)
(Joins sheet 206)
(Joins inset, sheet 208)
Kimball
KIMBALL CEMETERY
SAINT ANNES CEMETERY
SOO LINE
STEARNS COUNTY GAME REFUGE
Willow Lake
water
1 Mile
5 000 Feet
Scale 1:15 840


N
(Joins sheet 201)
R. 29 W.
R. 28 W.
(Joins sheet 205)
(Joins inset, sheet 207)
T. 121 N. Joins sheet 207
School Section Lake
Fairhaven
CONCORDIA CEMETERY
Mill Pond
Lake Marie
WRIGHT COUNTY
Lake Louisa
1 Mile
5 000 Feet
Scale 1:15 840

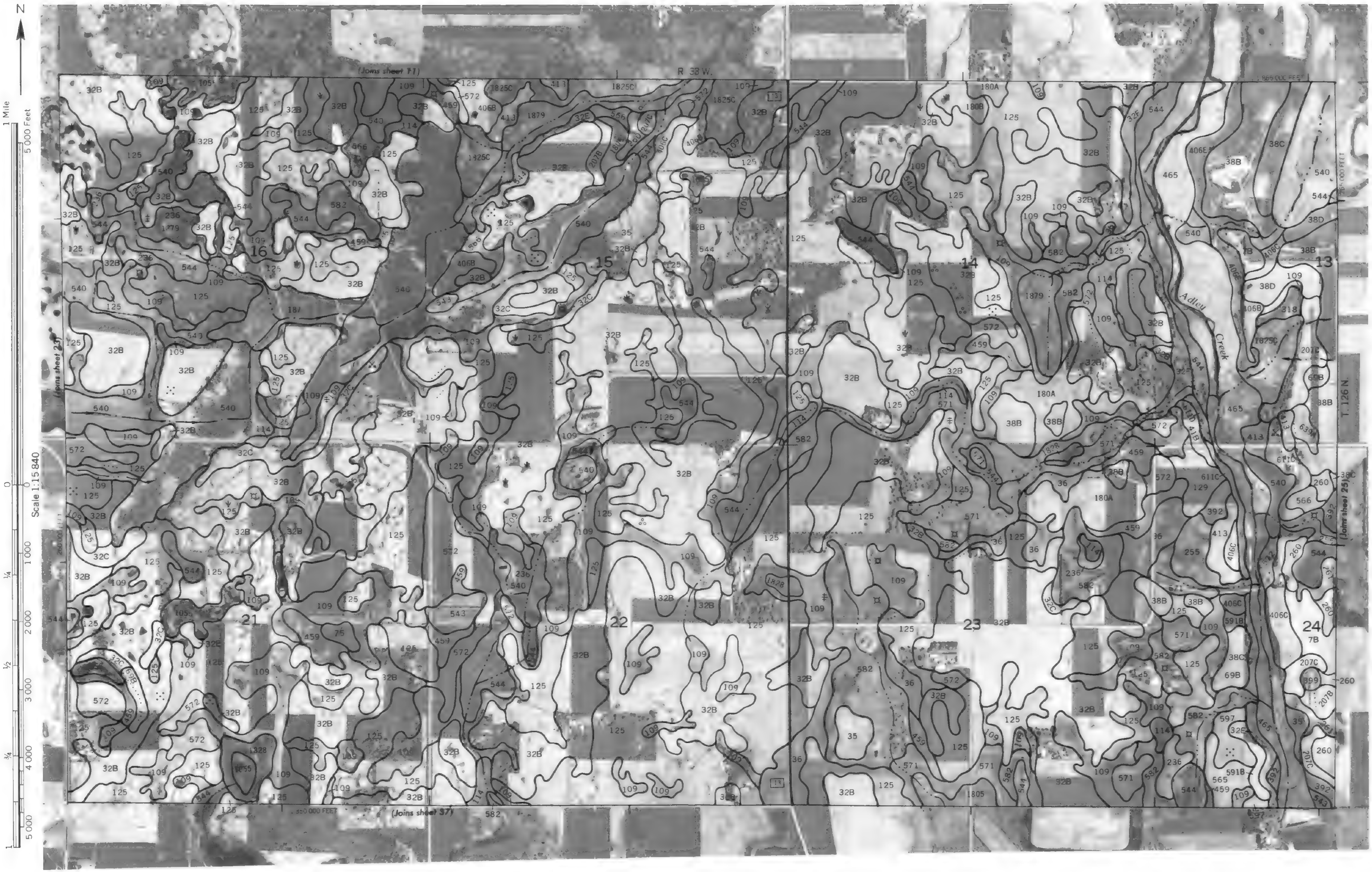

207
N
R. 28 W.
R. 29 W.
(Joins sheet 202)
(Joins sheet 208)
Otter Lake
water
Lake Caroline
WRIGHT COUNTY
CLEARWATER RIVER
CLEARWATER LAKE
Lake Augusta
MEEKER COUNTY
Camp Heritage
1 Mile
5 000 Feet
Scale 1:15 840

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 208

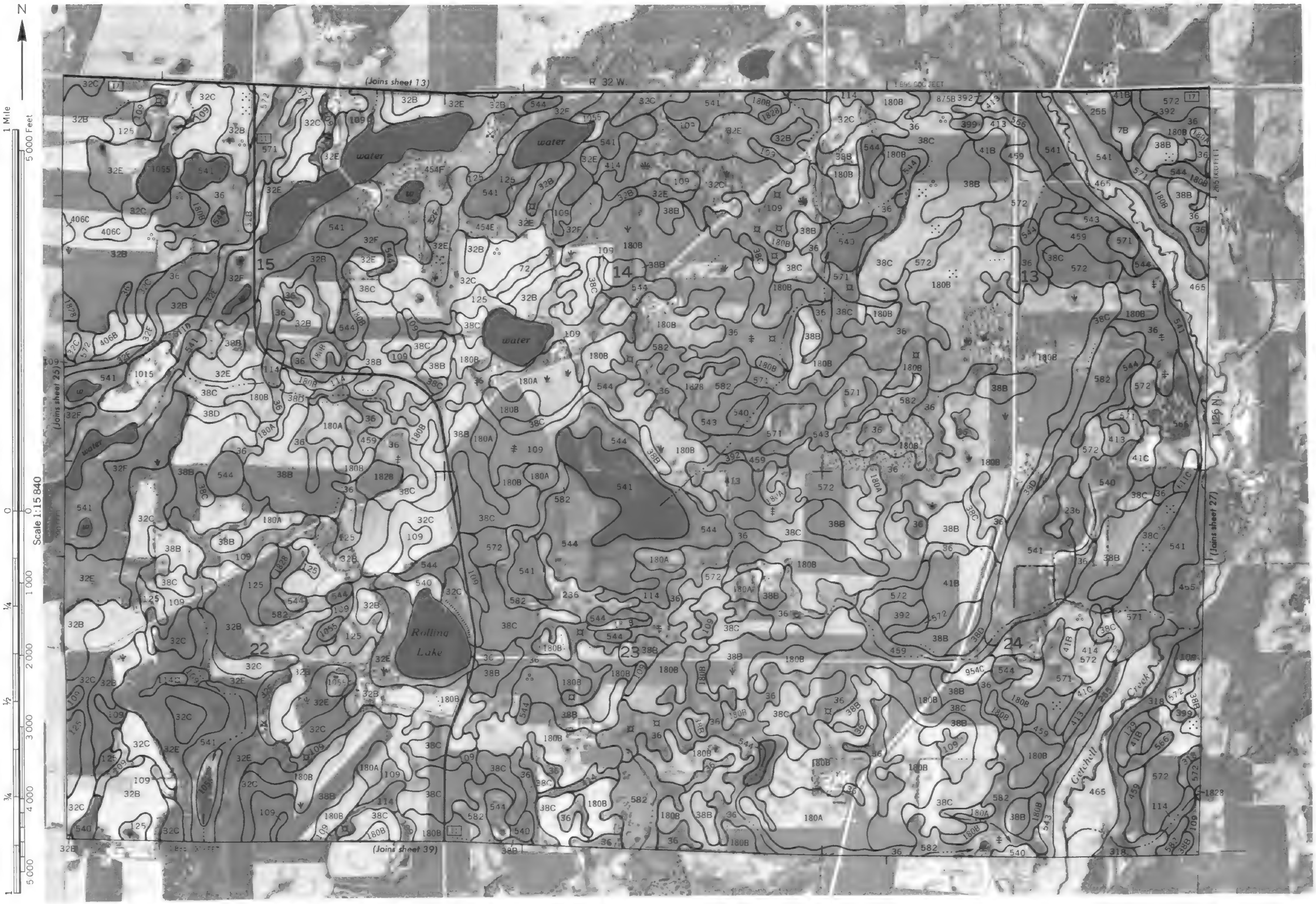

R. 35 W.
R. 34 W.
(Joins sheet 8)
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 24)
T. 126 N.
Hoboken
Creek
15
14
13
18
22
23
24
19
N
1 Mile
5 000 Feet
Scale 1:15 840

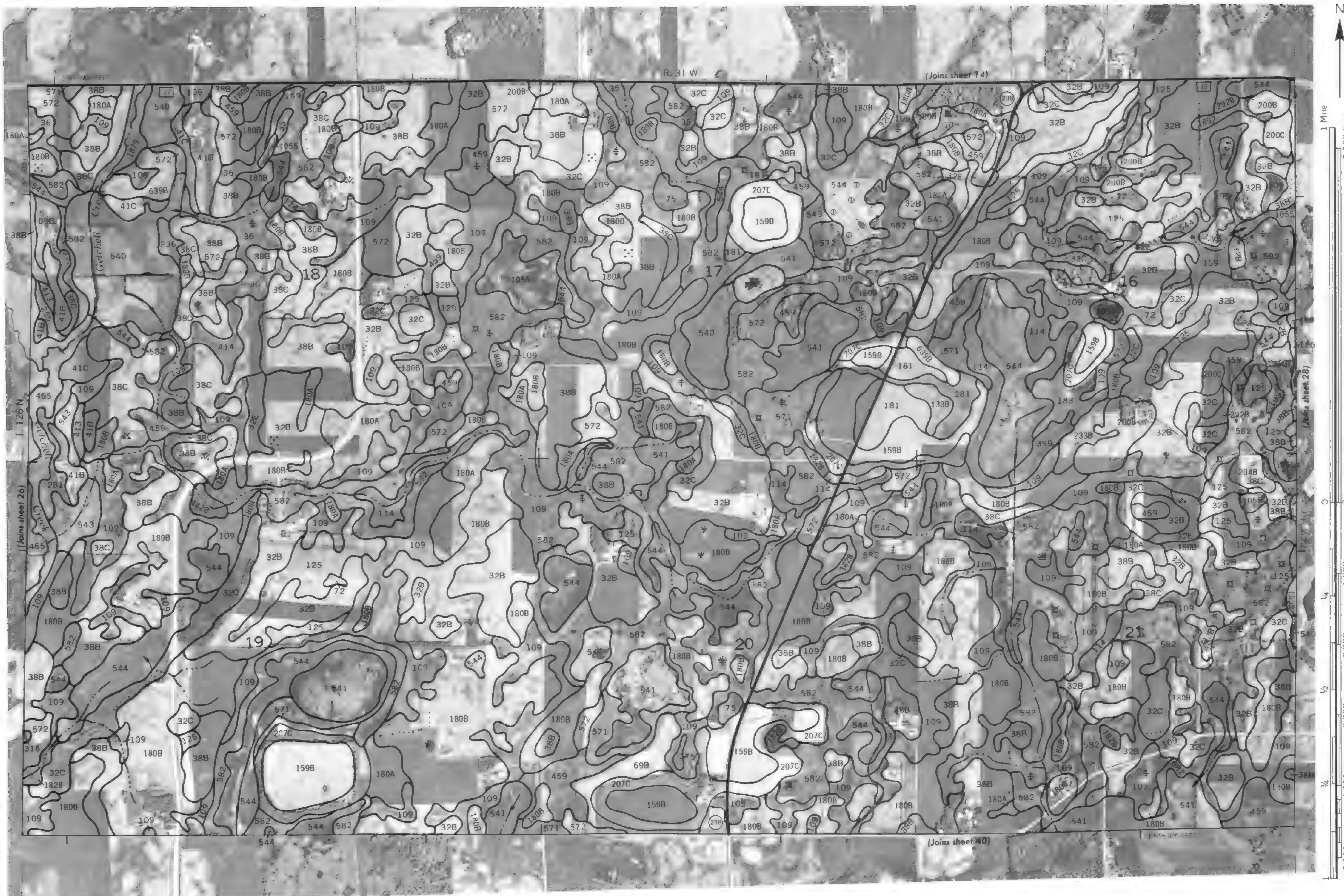

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 9)
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 35)
R. 34 W.
T. 126
SAUK
CENTRE
STEARNS
COUNTY
FAIRGROUND
SAUK CENTRE SANITARY LANDFILL
BURLINGTON
NORTHERN
SAUK
RIVER
SAUK CENTRE AIRSTRIP
water
14
15
16
17
20
21
22
23

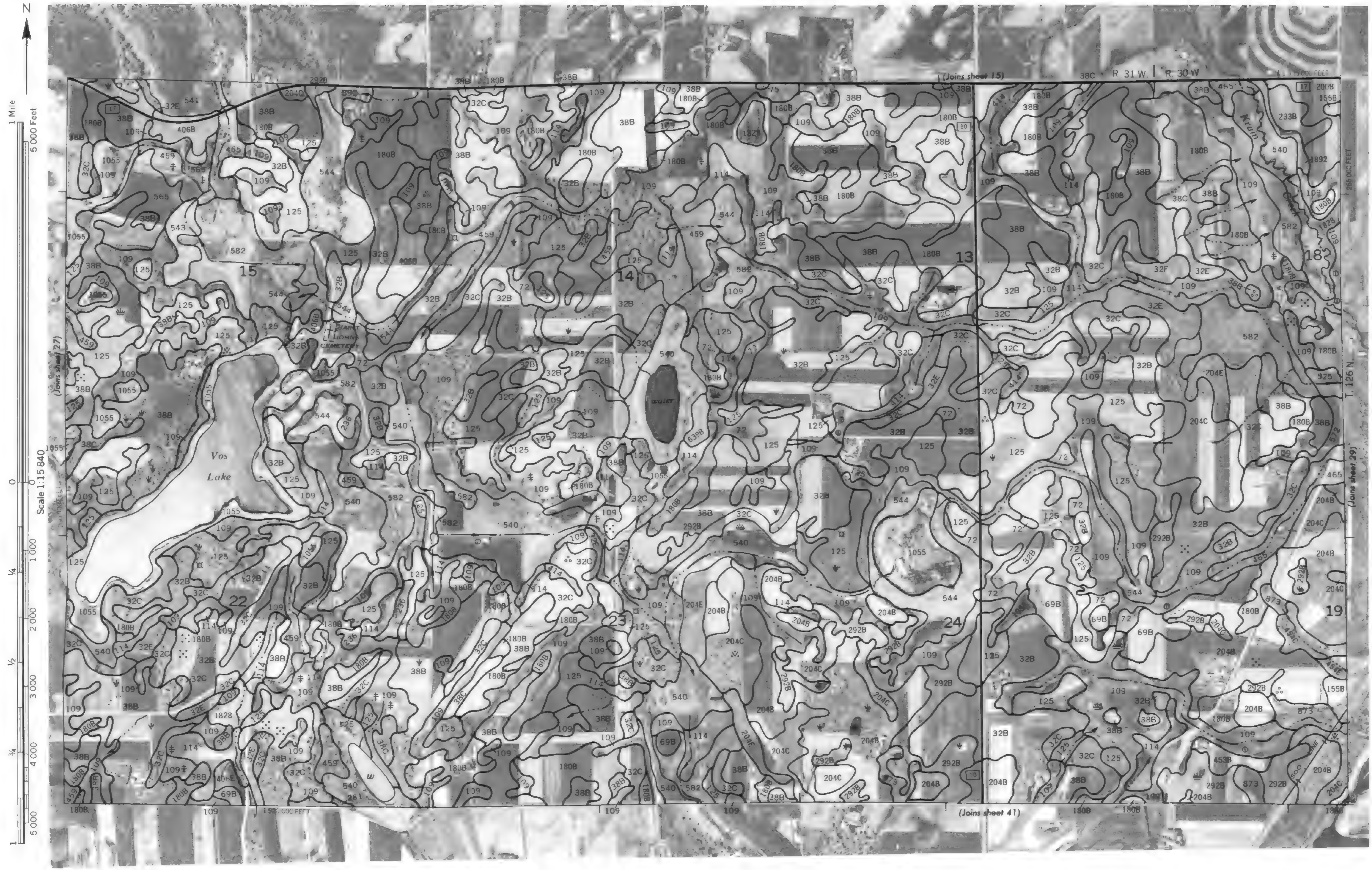

N
R. 34 W.
R. 33 W.
(Joins sheet 10)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 36)
T. 126 N.
McCormic Lake
water
water
water
water
water
1 845 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

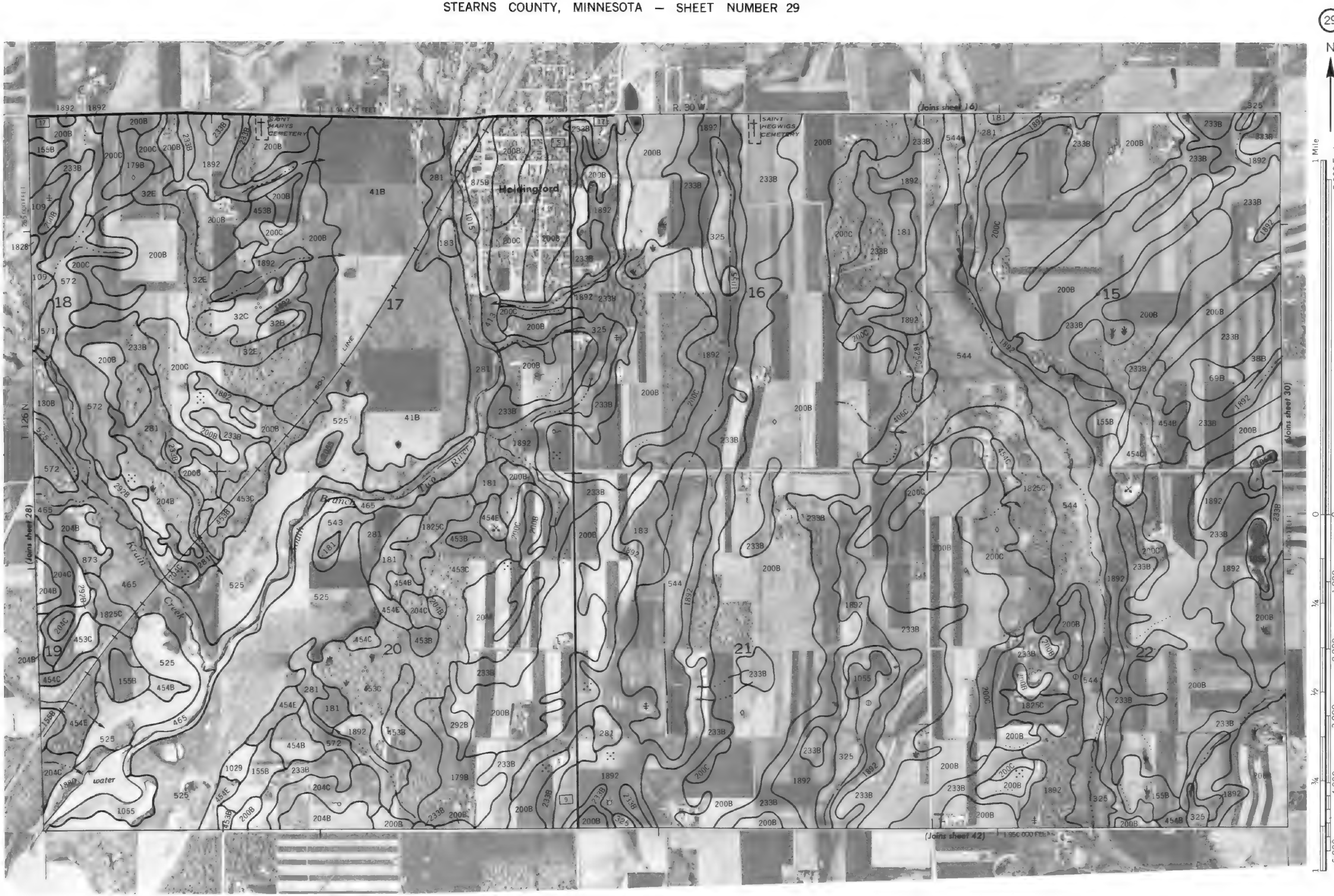

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 11)
R. 33 W.
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 37)
T. 126 N.
Adley Creek
16
15
14
13
21
22
23
24


N
(Joins sheet 12)
(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 38)
R. 33 W. | R. 32 W.
T. 126 N.
Saint Rosa
Cedar Lake
North Wolf Lake
Wolf Lake
Swamp Lake
Stone Lake
Long Lake
water
13
16
17
18
19
20
21
24
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 13)
R. 32 W.
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 39)
T. 126 N.
water
Rolling Lake
Getchell Creek
13
14
15
22
23
24


N
R. 31 W.
(Joins sheet 14)
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 40)
T. 126 N.
Getchell Creek
16
17
18
19
20
21
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
¼
2 000
½
3 000
¾
4 000
5 000
1
(Joins sheet 15)
R. 31 W.
R. 30 W.
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 41)
T. 126 N.
Vos
Lake
water
SAINT JOHNS CEMETERY
Kraın Creek
13
14
15
18
19
22
23
24


29
N
Holdingford
SAINT MARYS CEMETERY
SAINT HEDWIGS CEMETERY
R. 30 W.
T. 126 N.
(Joins sheet 16)
(Joins sheet 30)
(Joins sheet 42)
(Joins sheet 28)
Two River
South Branch
Krain Creek
LINE
water
17
18
16
15
19
20
21
22
Scale 1:15 840
1 Mile
5 000 Feet
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000

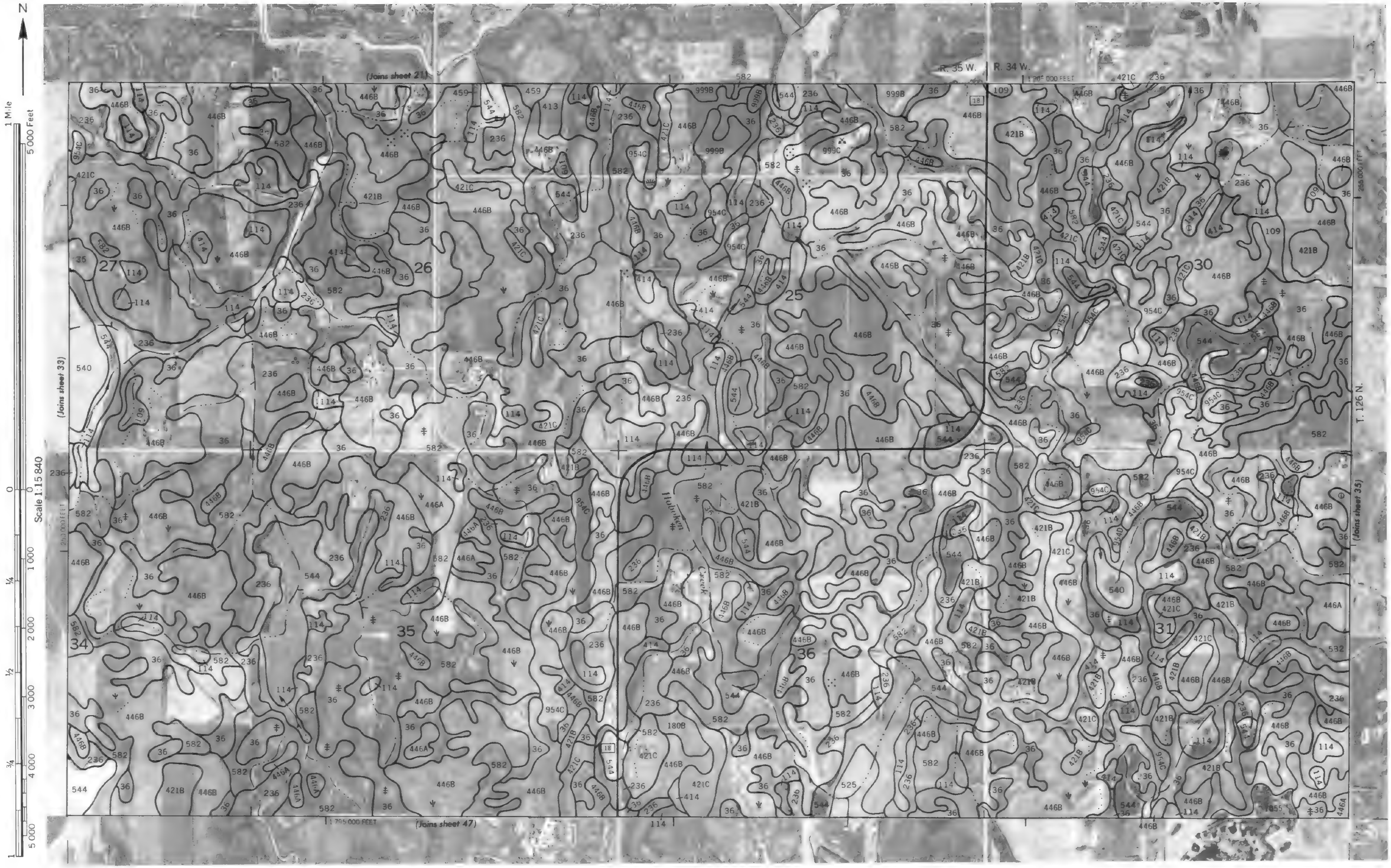

N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4
1
(Joins sheet 17)
(Joins sheet 43)
(Joins sheet 29)
(Joins sheet 31)
R. 30 W.
R. 29 W.
126 N.
14
13
18
17
23
24
19
20
Spunk Creek
Creek
Spunk
955 000 FEET
260 000 FEET


N
R. 29 W.
(Joins sheet 18)
(Joins sheet 32)
(Joins sheet 44)
(Joins sheet 30)
T. 126 N.
Stony Creek
14
15
16
17
20
21
22
23
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4
1


32
N
1 Mile
5 000 Feet
Scale 1:15 840
R. 29 W.
R. 28 W.
(Joins sheet 19)
(Joins sheet 31)
(Joins sheet 45)
MISSISSIPPI
RIVER
BENTON
COUNTY
Saint Stephen
13
18
17
16
24
19
20
21

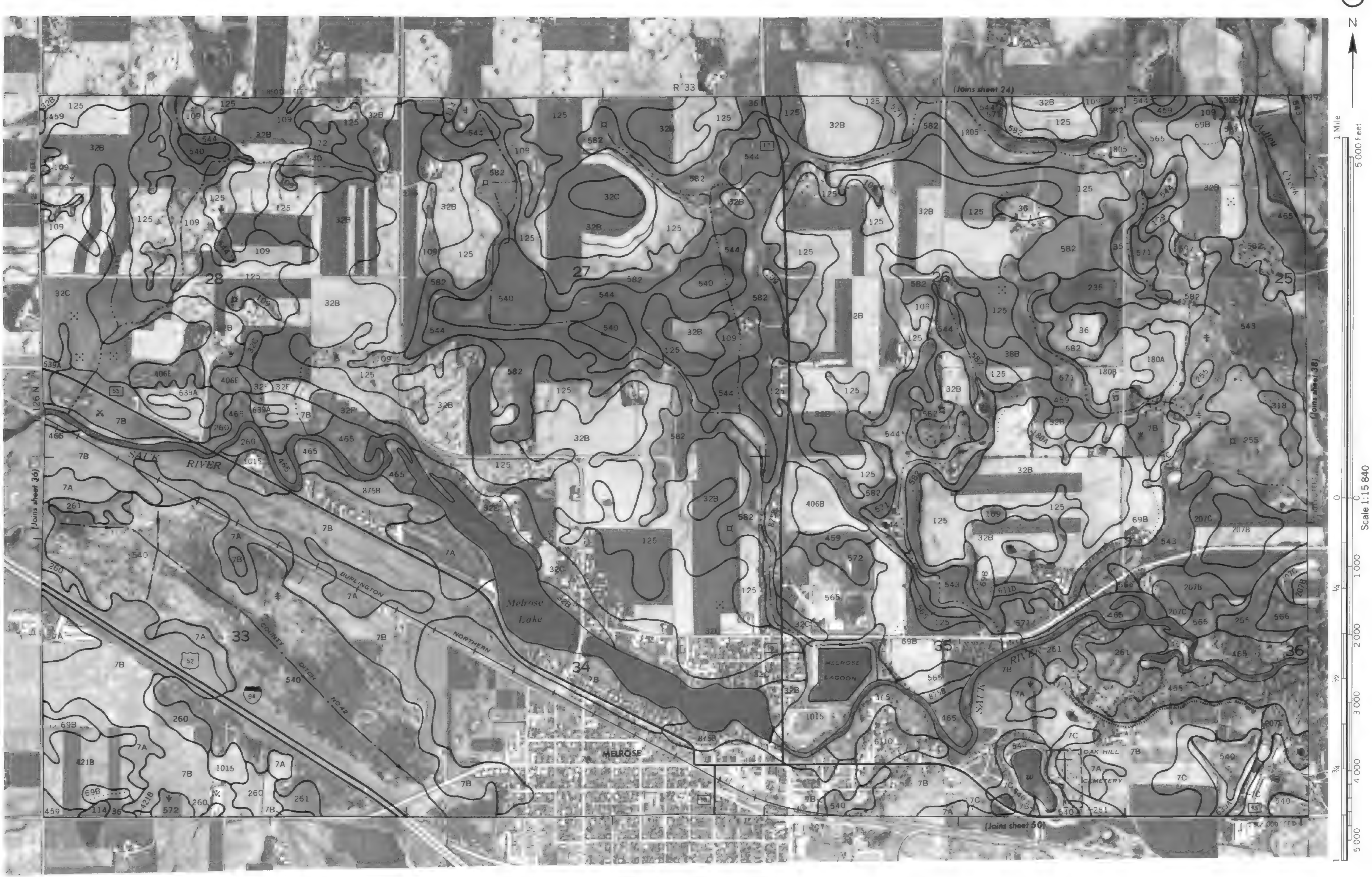

N
R. 35 W.
(Joins sheet 20)
(Joins sheet 34)
(Joins sheet 46)
POPE COUNTY T. 126 N.
SAINT JOHNS CEMETERY
water
1 Mile
5 000 Feet
Scale 1:15 840

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 34




N
(Joins sheet 22)
(Joins sheet 48)
(Joins sheet 34)
(Joins sheet 36)
R. 34 W.
T. 126 N.
1 810 000 FEET
255 000 FEET
SAUK
RIVER
26
27
28
29
32
33
34
35
Scale 1:15 840
1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1

STEARNS COUNTY, MINNESOTA — SHEET NUMBER 36


N
R 33
(Joins sheet 24)
(Joins sheet 36)
(Joins sheet 38)
(Joins sheet 50)
T 126 N
28
27
26
25
33
34
35
36
SAUK RIVER
SAUK RIVER
Melrose Lake
MELROSE
MELROSE LAGOON
BURLINGTON NORTHERN
COUNTY DITCH NO 42
OAK HILL CEMETERY
Adley Creek
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
R. 33 W. | R. 32 W.
(Joins sheet 25)
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 51)
T. 126 N.
Cedar Lake
Stone Lake
Long Lake
Knaus Lake
water
Adley Creek
SAUK RIVER
MELROSE SANITARY LANDFILL
25
28
29
30
31
32
33
36

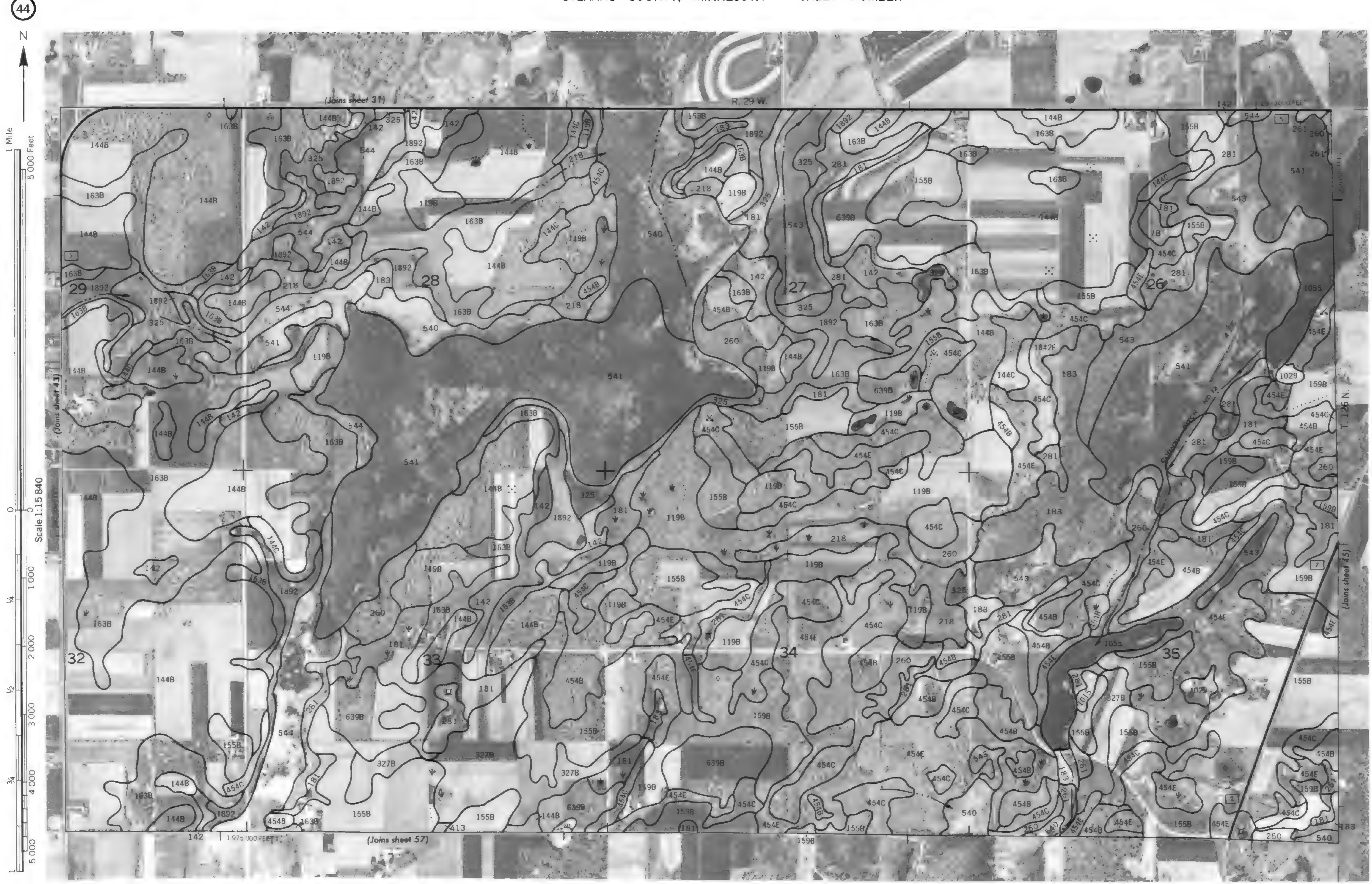

N
R. 32 W.
(Joins sheet 26)
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 52)
T. 126 N.
255 000 FEET
1 895 000 FEET
Kings Lake
Freeport Lake
Getchell Creek
27
26
25
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
0
1000
2000
3000
4000
5000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 27)
R. 31 W.
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 53)
T. 126 N.
Saint Anthony
30
29
28
31
32
33
County Ditch No 22


(Joins sheet 28)
R. 31 W.
R. 30 W.
T. 126 N.
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 54)
Bear Lake
Fish Lake
Littner Lake
TWO RIVER LAKE
25
26
27
30
31
34
35
36
N
1 Mile
5 000 Feet
Scale 1:15 840

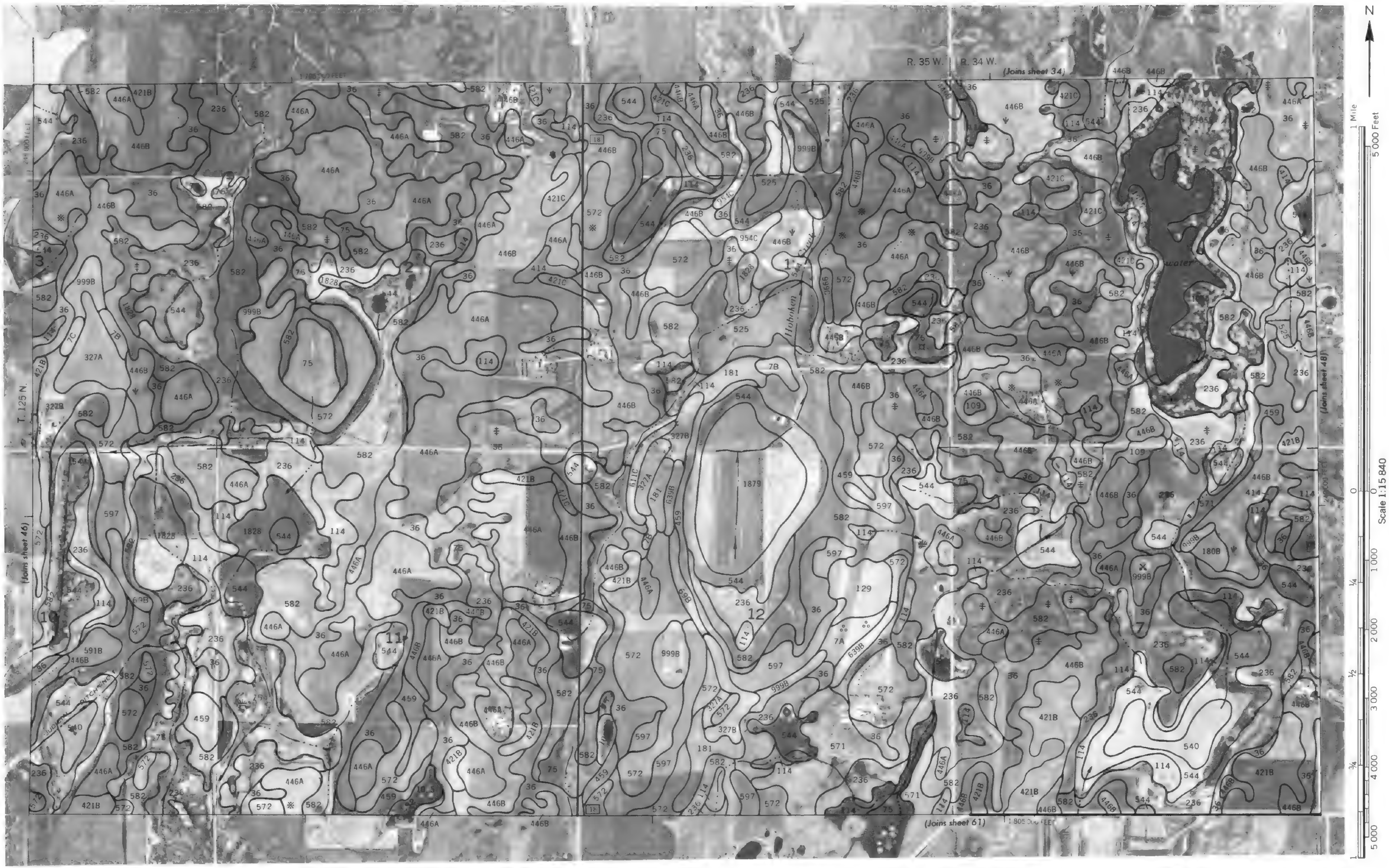

N
(Joins sheet 29)
R. 30 W.
(Joins sheet 41)
(Joins sheet 43)
(Joins sheet 55)
T. 126 N.
Two River Lake
Two River Lake
30
29
28
27
31
32
33
34
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000


R. 30 W.
R. 29 W.
(Joins sheet 30)
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 56)
T. 126 N.
Spunk Creek
COUNTY DITCH NO 18
water
26
25
30
29
35
36
31
32
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000

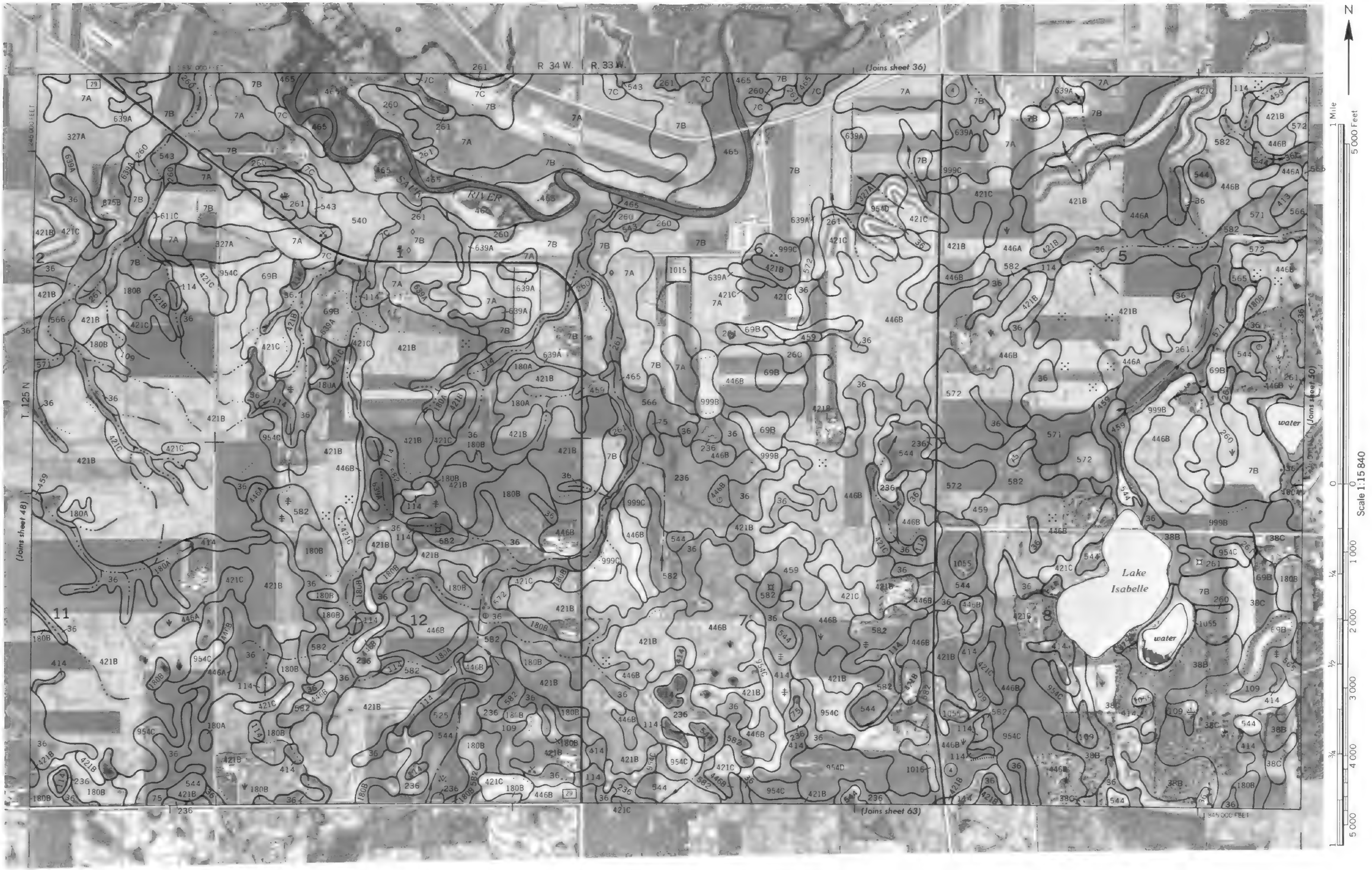

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 31)
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 57)
R. 29 W.
T. 126 N.
1 975 000 FEET
29
28
27
26
32
33
34
35


(Joins sheet 32)
(Joins sheet 58)
(Joins sheet 44)
(Joins inset, sheet 143)
Saint Stephen
MISS. R.
BROCKWAY CEMETERY
R. 29 W.
T. 126 N.
25
29
28
30
31
32
33
36
1 Mile
5 000 Feet
Scale 1:15 840
N

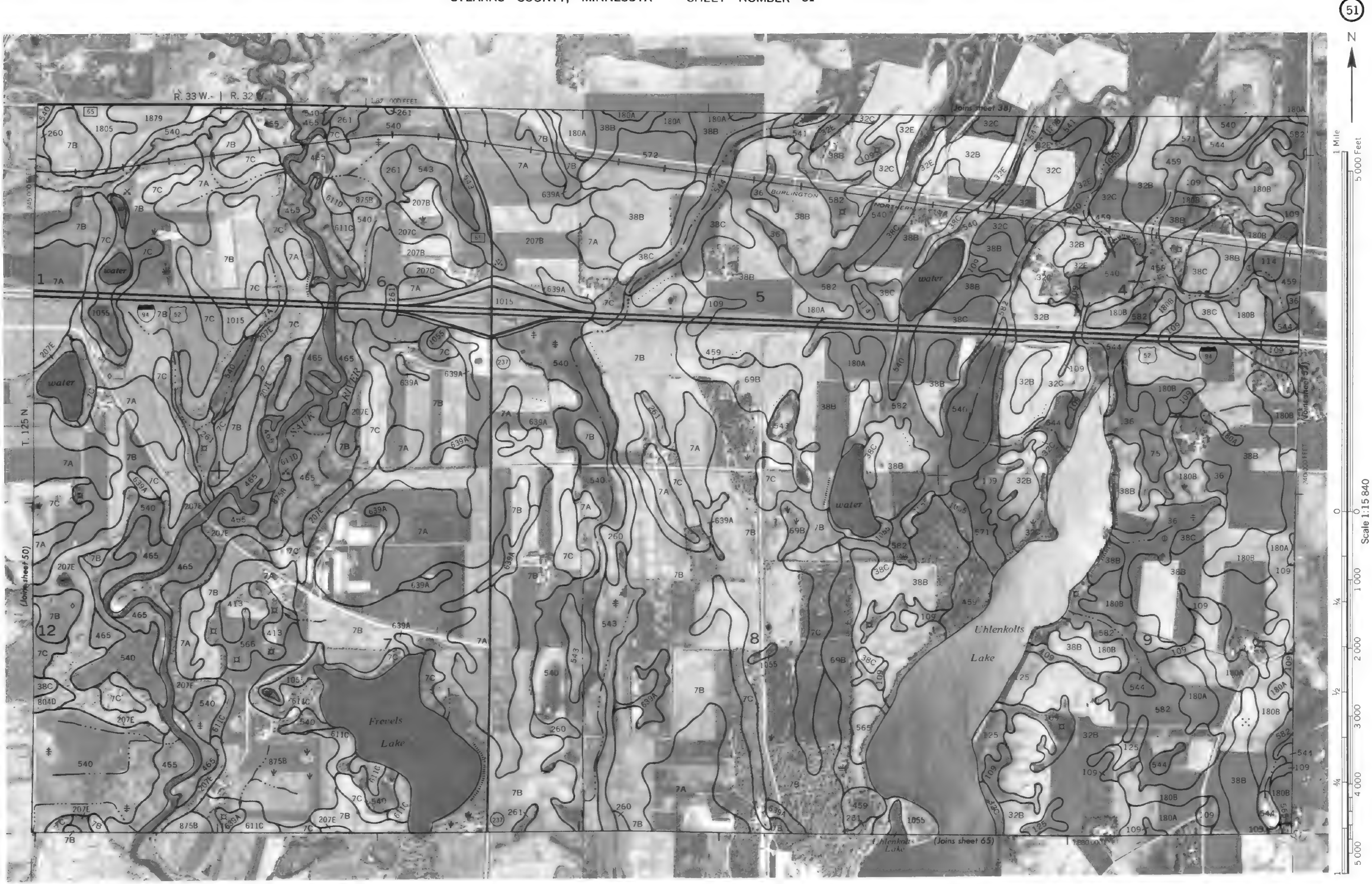

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 33)
R. 35 W.
T. 125 N.
(Joins sheet 47)
(Joins sheet 60)
POPE COUNTY
LYMAN PRAIRIE CEMETERY
COUNTY DITCH NO.
J.D. NO.


R. 35 W.
R. 34 W.
(Joins sheet 34)
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 61)
T. 125 N.
Hoboken Creek
water
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
1/4
1/2
3/4
1

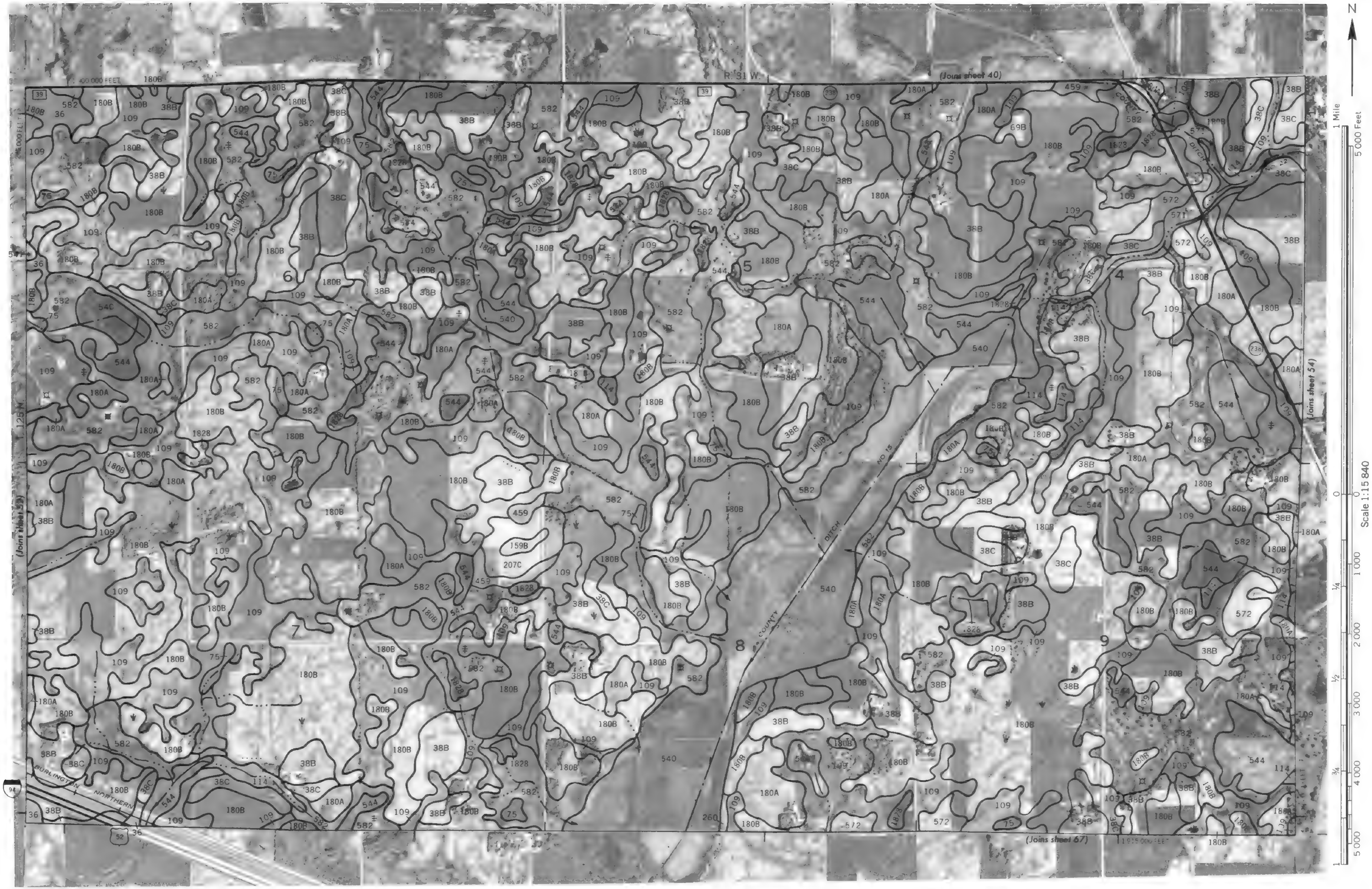

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 35)
R. 34 W.
1 825 000 FEET
745 000 FEET
(Joins sheet 47)
(Joins sheet 49)
T. 125 N.
water
water
water
BOHEMIAN CEMETERY
1 810 000 FEET
(Joins sheet 62)


(Joins sheet 36)
(Joins sheet 63)
(Joins sheet 48)
(Joins sheet 50)
R. 34 W.
R. 33 W.
T. 125 N
SAUK RIVER
Lake Isabelle
water
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 37)
R. 33 W.
MELROSE
SAINT PATRICK CEMETERY
SAINT MARYS CEMETERY
BURLINGTON NORTHERN
COUNTY DITCH NO 42
2 365 000 FEET
245 000 FEET
T. 125 N.
(Joins sheet 49)
(Joins sheet 51)
(Joins sheet 64)
water

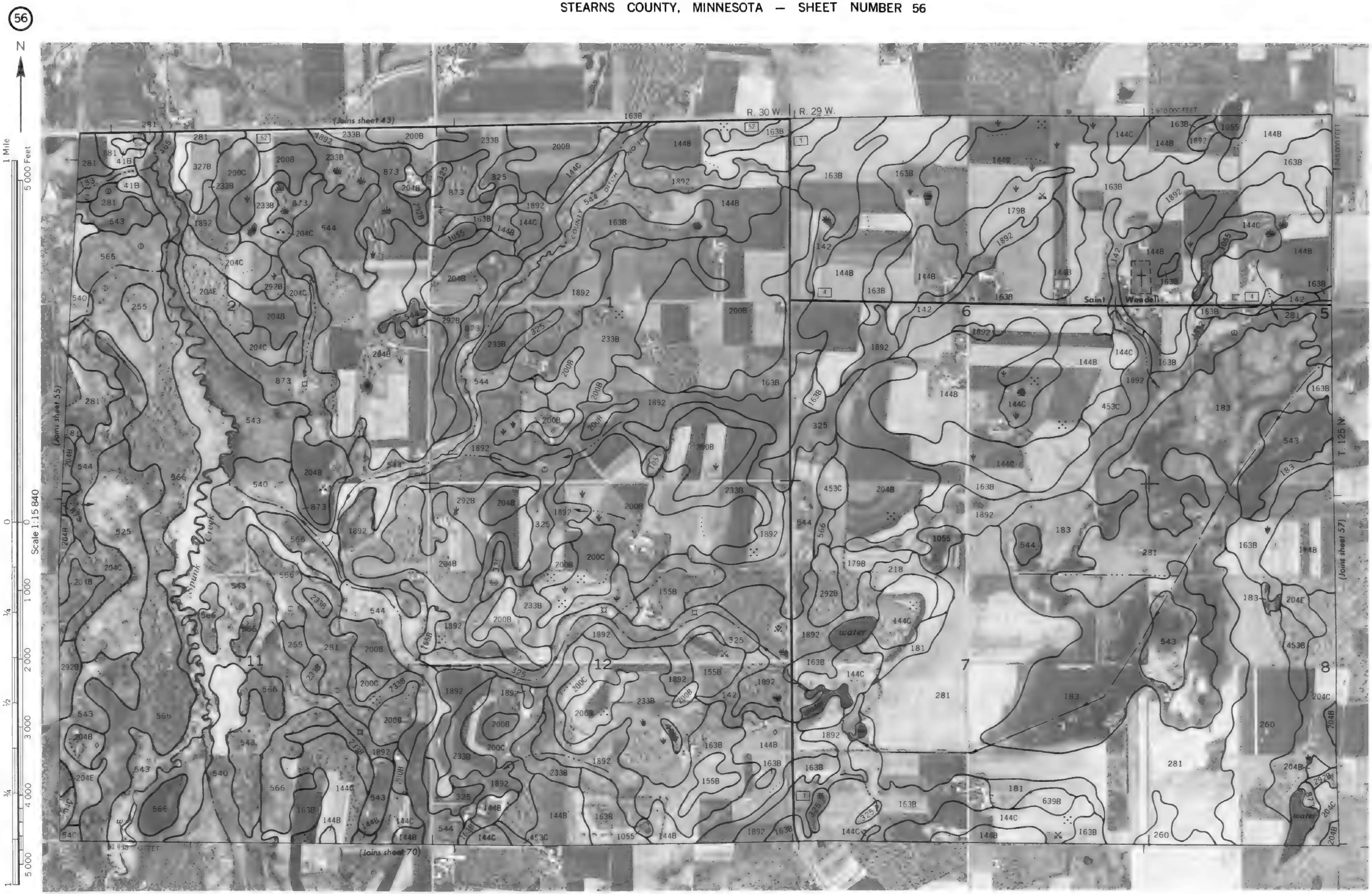

51
N
R. 33 W. | R. 32 W.
T. 125 N
(Joins sheet 38)
(Joins sheet 50)
(Joins sheet 65)
BURLINGTON NORTHERN
SAUK RIVER
water
Frevels Lake
Uhlenkolts Lake
Scale 1:15 840
1 Mile
5 000 Feet


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 39)
R. 32 W.
895 000 FEET
Freeport Lake
Freeport
BURLINGTON NORTHERN
Getchell Creek
FREEPORT LAGOON
COUNTY DITCH NO 28
T. 125 N.
(Joins sheet 51)
(Joins sheet 53)
(Joins sheet 66)


(Joins sheet 40)
R. 31 W.
T. 125 N.
(Joins sheet 52)
(Joins sheet 54)
(Joins sheet 67)
BURLINGTON NORTHERN
COUNTY DITCH NO 15
N
1 Mile
5 000 Feet
Scale 1:15 840

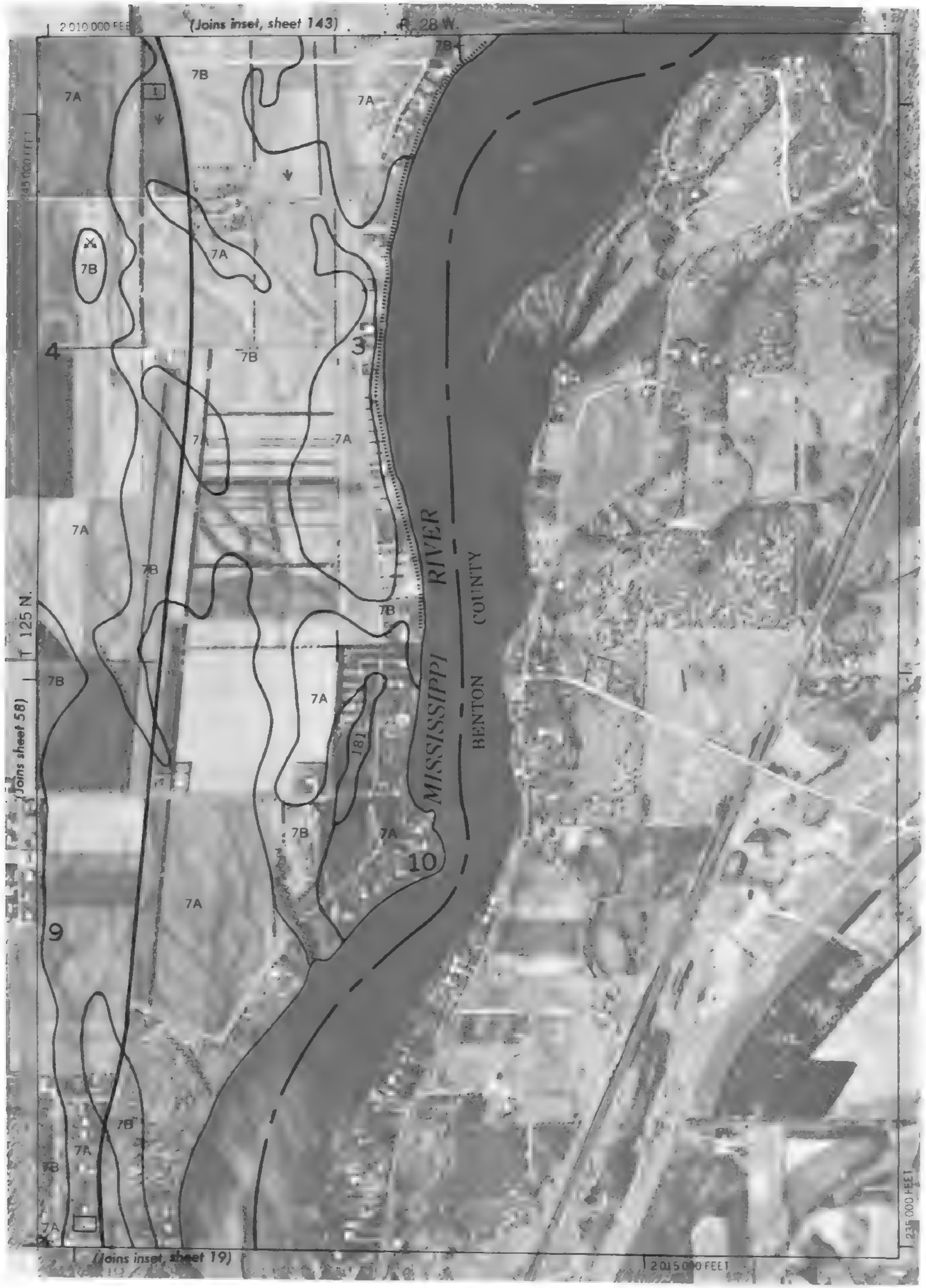

N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
¼
2 000
½
3 000
¾
4 000
5 000
(Joins sheet 41)
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 68)
R. 31 W.
R. 30 W.
T. 125 N.
Two River Lake
Pine Lake
Little Pine Lake
South Branch Two River
2
3
6
7
10
11
12


N
R 30 W
(Joins sheet 42)
(Joins sheet 56)
(Joins sheet 69)
(Joins sheet 54)
T 125 N.
Two River Lake
PELICAN LAKE
Little Pelican Lake
Little Pine Lake
water
IMMACULATE CONCEPTION CEMETERY
Saint Anna
1 Mile
5 000 Feet
Scale 1:15 840


56
N
(Joins sheet 43)
R. 30 W.
R. 29 W.
(Joins sheet 55)
(Joins sheet 57)
(Joins sheet 70)
T. 125 N.
Saint Wendell
Spunk Creek
County Ditch No. 19
Scale 1:15 840
1 Mile
5 000 Feet


R. 29 W.
(Joins sheet 44)
(Joins sheet 58)
(Joins sheet 71)
(Joins sheet 56)
T. 125 N.
COUNTY DITCH NO 12
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 45)
R. 29 W.
R. 28 W.
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 72)
T. 125 N.
water
Watab Lake
1
4
5
6
7
8
9
12

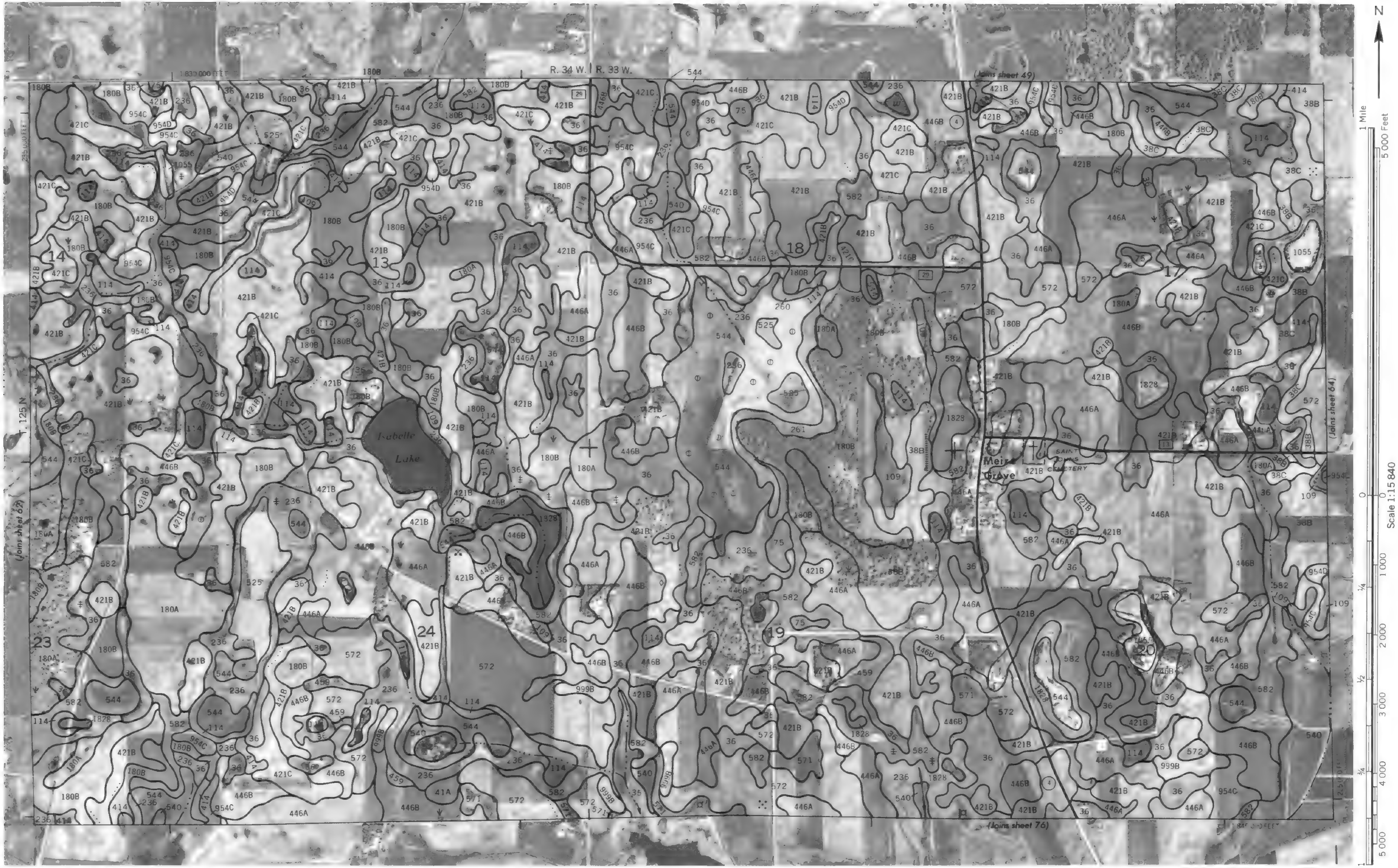


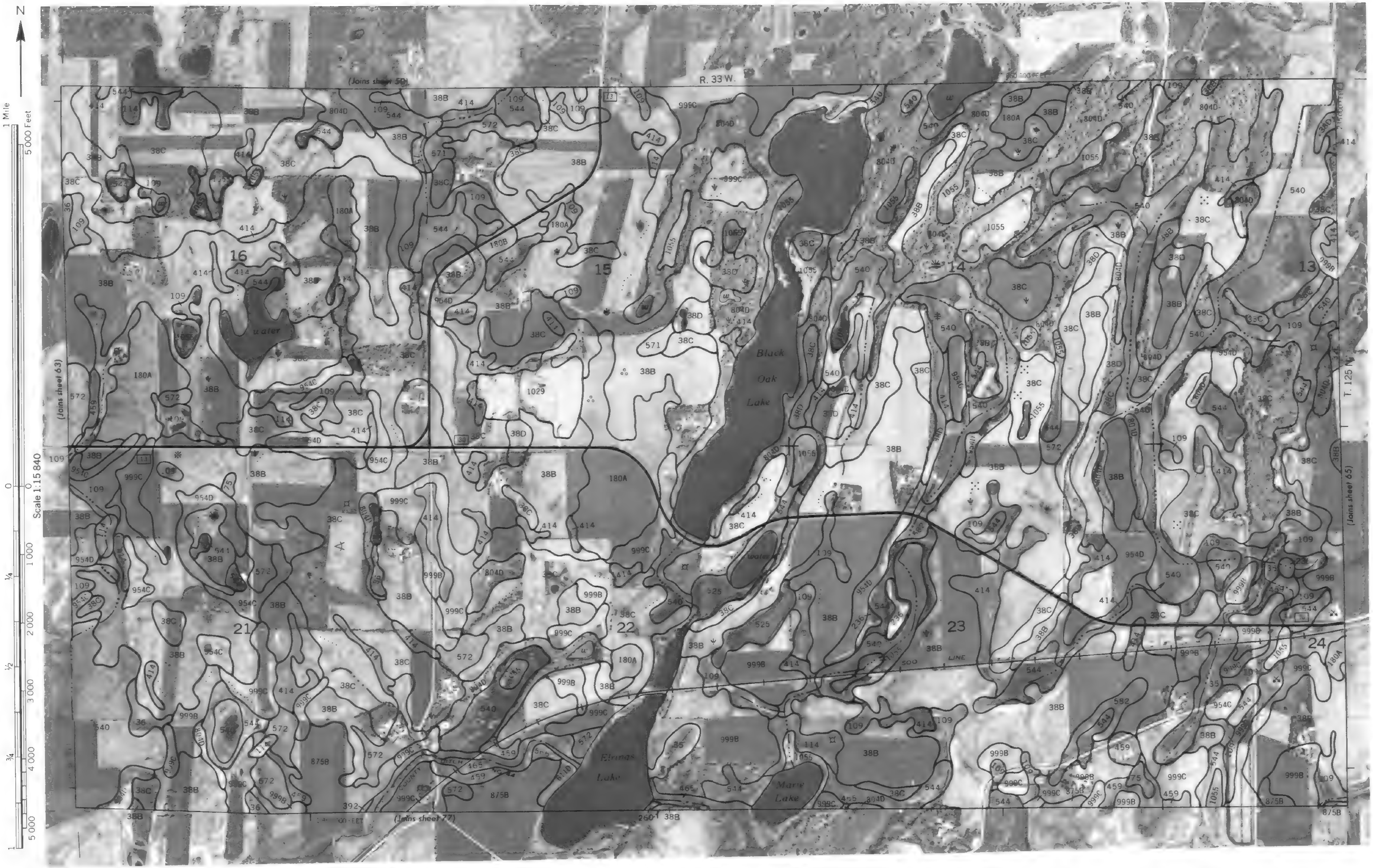
2000-FOOT GRID TICKS


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 46)
R. 35 W.
T. 125 N.
(Joins sheet 61)
(Joins sheet 73)
775 000 FEET
POPE COUNTY
JUDICIAL DITCH NO 1
water
15
16
17
18
19
20
21
22

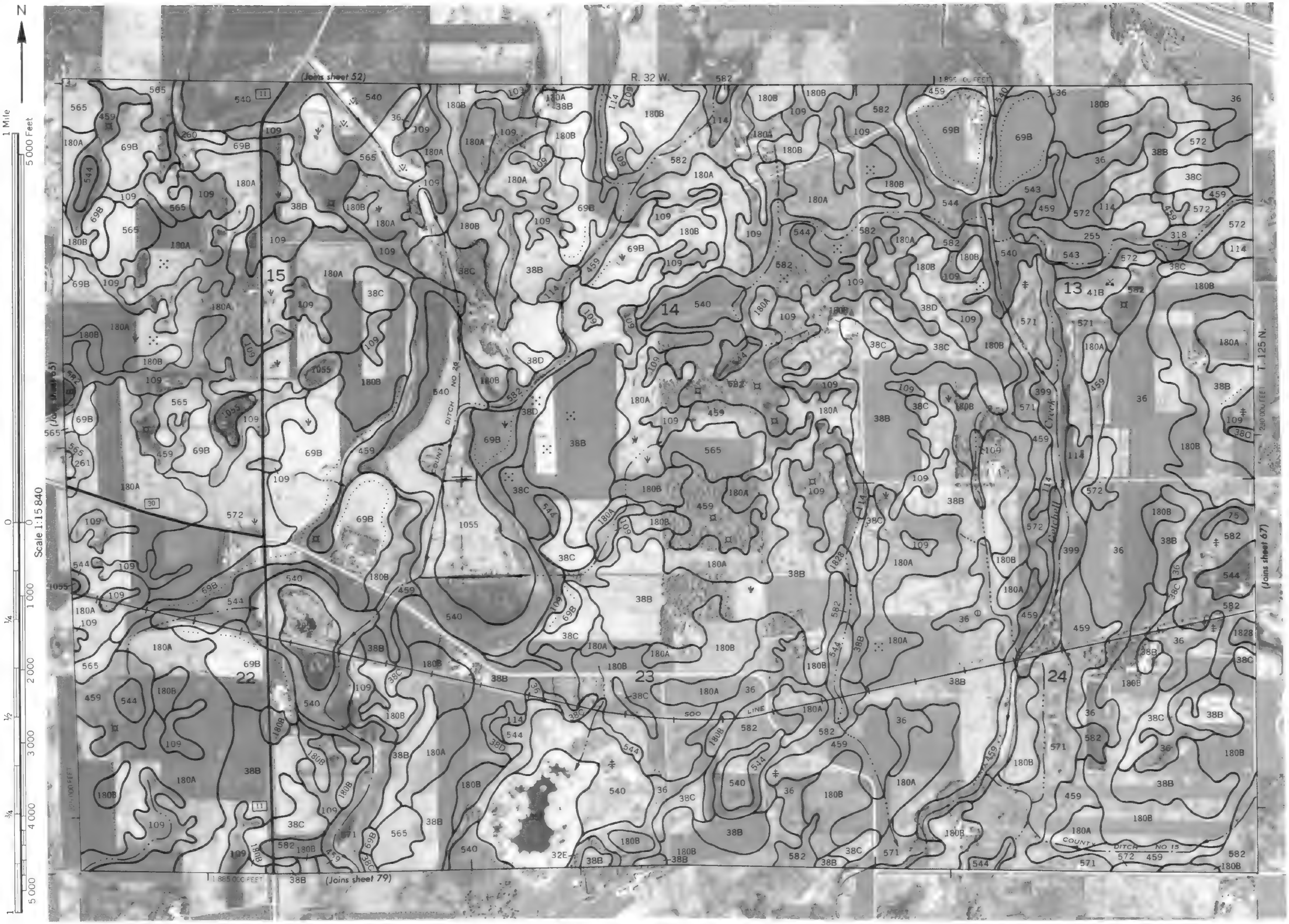

R. 35 W.
R. 34 W.
(Joins sheet 47)
(Joins sheet 60)
(Joins sheet 62)
(Joins sheet 74)
T. 125 N.
Raymond Lake
water
PADUA STATE WILDLIFE MANAGEMENT AREA
STATE WILDLIFE MANAGEMENT AREA
Padua
13
14
15
18
19
22
23
24
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 48)
R. 34 W.
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 75)
17
16
15
14
20
21
22
23


R. 34 W. | R. 33 W.
(Joins sheet 49)
(Joins sheet 62)
(Joins sheet 64)
(Joins sheet 76)
T. 125 N.
Isabelle Lake
Meire Grove
SAINT JOHNS CEMETERY
14
13
18
17
23
24
19
20
N
1 Mile
5 000 Feet
Scale 1:15 840

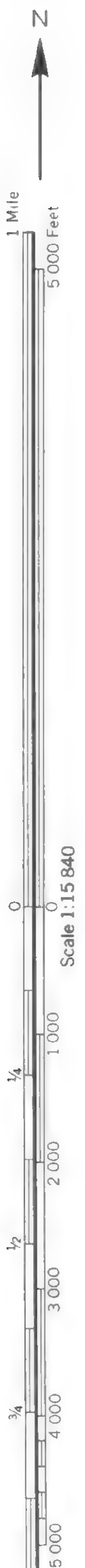

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 50)
(Joins sheet 63)
(Joins sheet 65)
(Joins sheet 77)
R. 33 W.
T. 125 N.
Black Oak Lake
Eilenas Lake
Marie Lake
water
16
15
14
13
21
22
23
24

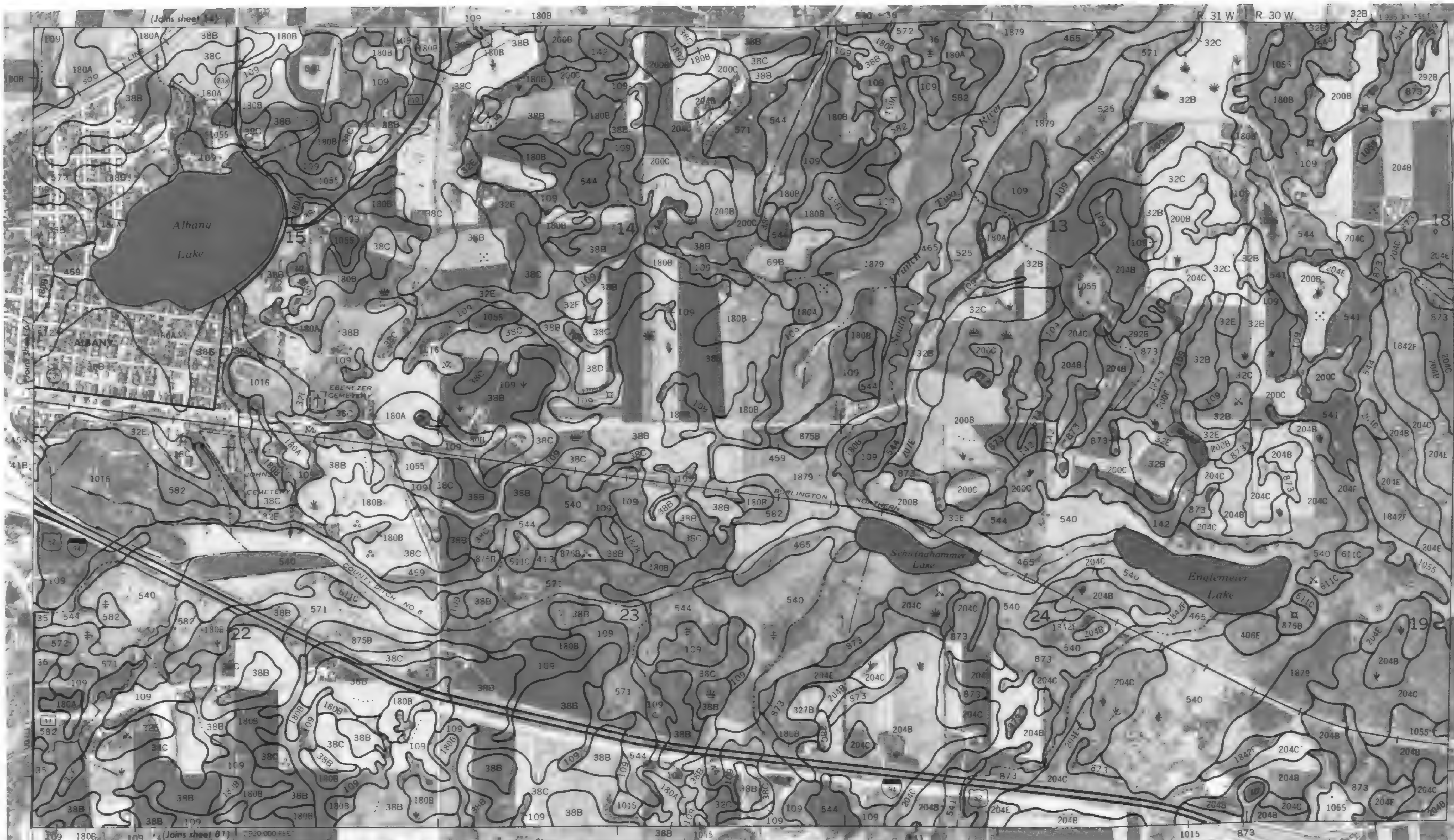

R. 33 W.
R. 32 W.
T. 125 N.
(Joins sheet 51)
(Joins sheet 64)
(Joins sheet 66)
(Joins sheet 78)
Frevels Lake
Uhlenkolts Lake
Lake Maria
water
SAUK RIVER
New Munich
IMMACULATE CONCEPTION CEMETERY
NEW MUNICH LAGOON
SOO LINE
13
16
17
18
19
20
21
24
N
1 Mile
5 000 Feet
Scale 1:15 840


N
(Joins sheet 52)
R. 32 W.
T. 125 N.
(Joins sheet 67)
(Joins sheet 79)
(Joins sheet 65)
1 Mile
5 000 Feet
Scale 1:15 840
15
14
13
22
23
24
COUNTY DITCH NO 24
Catchall Creek
COUNTY DITCH NO 15
500 LINE


(Joins sheet 53)
(Joins sheet 66)
(Joins sheet 80)
R. 31 W.
T. 125 N.
BURLINGTON NORTHERN
ALBANY
ALBANY LAGOON
N
1 Mile
5 000 Feet
Scale 1:15 840

68


N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000


(Joins sheet 14)
(Joins sheet 81)
(Joins sheet 69)
(Joins sheet 67)
R. 31 W.
R. 30 W.
Albany Lake
ALBANY
EBENEZER CEMETERY
CEMETERY
Schwinghammer Lake
Englemeier Lake
South Branch Two River
BURLINGTON NORTHERN
COUNTY DITCH NO 6
13
14
15
18
19
22
23
24


(Joins sheet 55)
(Joins sheet 70)
(Joins sheet 82)
(Joins sheet 68)
R. 30 W.
T. 125 N.
Lower Spunk Lake
Ochotto Lake
Spunk
Avon
BURLINGTON NORTHERN
water
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 56)
(Joins sheet 69)
(Joins sheet 71)
(Joins sheet 83)
R. 30 W.
R. 29 W.
1 970 000 FEET
T. 125 N.
14
13
18
17
23
24
19
20
water
COUNTY DITCH NO 25
BURLINGTON NORTHERN
Swamp Lake
Kepper Lake

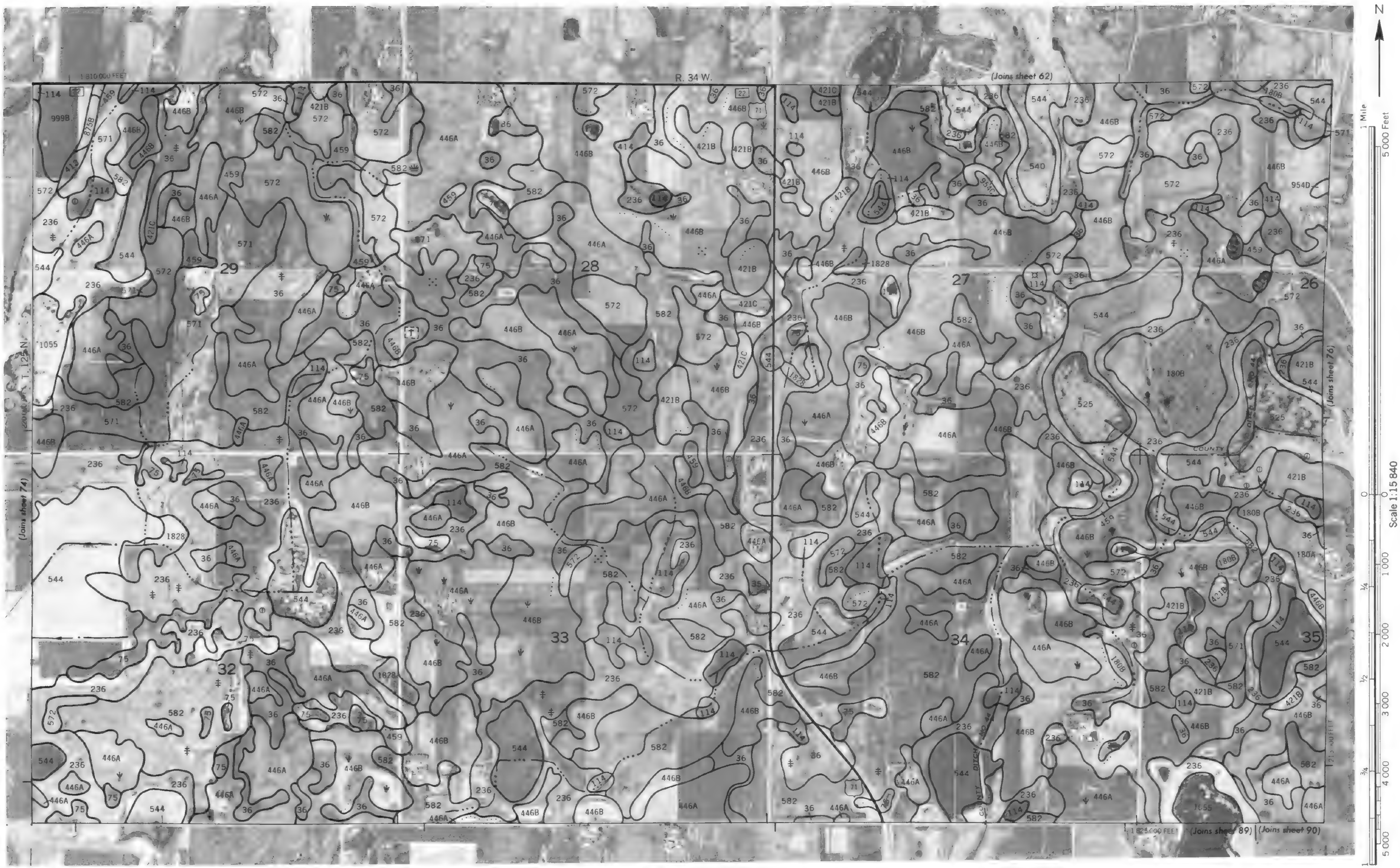

N
R. 29 W.
(Joins sheet 57)
T. 125 N.
(Joins sheet 70)
(Joins sheet 72)
(Joins sheet 84)
16
15
14
17
20
21
22
23
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 58)
R. 29 W.
R. 28 W.
Watab Lake
COUNTY DITCH NO 13
(Joins sheet 71)
(Joins inset, sheet 19)
T. 125 N.
Watab River
SARTELL
(Joins sheet 85)
13
18
17
16
24
19
20
21

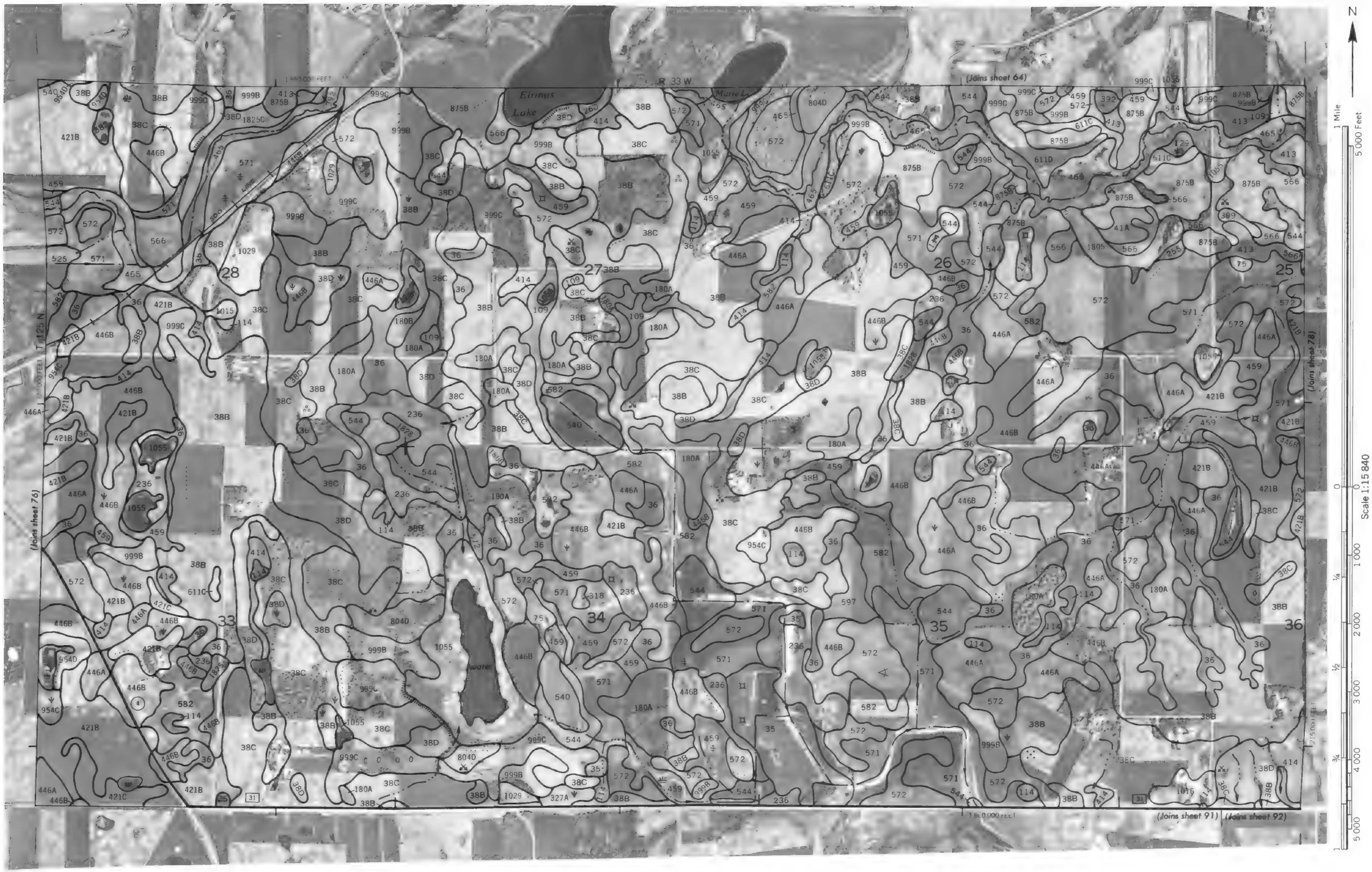

N
R. 35 W.
(Joins sheet 60)
(Joins sheet 74)
(Joins sheet 87)
(Joins sh 88)
T. 125 N.
POPE COUNTY
POPE COUNTY
North Fork Crow River
JUDICIAL DITCH NO.
29
28
27
30
31
32
33
34
1 Mile
5 000 Feet
Scale 1:15 840

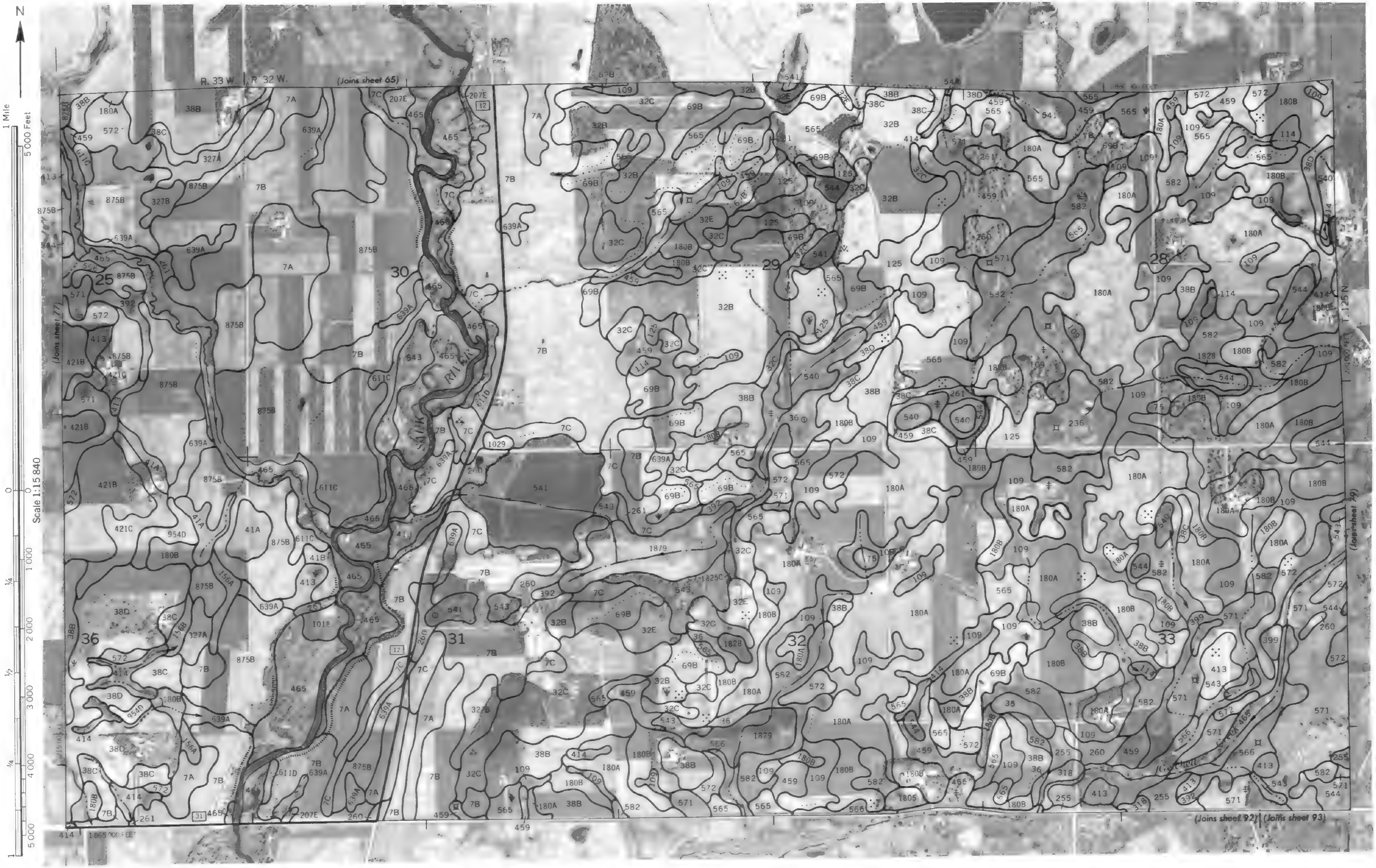
STEARNS COUNTY, MINNESOTA — SHEET NUMBER 74

75


R. 34 W.
(Joins sheet 62)
(Joins sheet 74)
(Joins sheet 76)
(Joins sheet 89)
(Joins sheet 90)
T. 122 N.
27
28
29
32
33
34
35
26
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 63)
R. 34 W. | R. 33 W.
(Joins sheet 75)
(Joins sheet 77)
(Joins sheet 90) (Joins sheet 91)
T. 125 N.
Greenwald
SAINT ANDREW CEMETERY
COUNTY DITCH NO 44
water
1 845 000 FEET
1 830 000 FEET
25
26
29
30
31
32
35
36


77
N
(Joins sheet 64)
R. 33 W.
T. 125 N.
Eirinas Lake
(Joins sheet 76)
(Joins sheet 78)
(Joins sheet 91)
(Joins sheet 92)
water
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
0
1/4
1/2
3/4
1


N
R. 33 W.
R. 32 W.
(Joins sheet 65)
(Joins sheet 77)
(Joins sheet 79)
(Joins sheet 92)
(Joins sheet 93)
T. 125 N.
SAUK RIVER
25
30
29
28
36
31
32
33
1 Mile
5 000 Feet
Scale 1:15 840


(Joins sheet 66)
R. 32 W.
T. 125 N.
(Joins sheet 78)
(Joins sheet 80)
(Joins sheet 93)
Getchell Creek
Getchell Lake
SAND LAKE
COUNTY DITCH NO. 29
27
26
25
34
35
36
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 67)
R. 31 W.
T. 125 N.
(Joins sheet 79)
(Joins sheet 81)
Sand Lake
IMMANUEL CEMETERY
COUNTY DITCH NO 6
30
29
28
31
32
33
1 915 000 FEET
215 000 FEET


(Joins sheet 68)
R. 31 W.
R. 30 W.
(Joins sheet 82)
(Joins sheet 80)
(Joins sheet 94)
(Joins sheet 95)
T. 125 N.
Fifth Lake
Sand Lake
water
25
26
27
30
31
34
35
36
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 69)
R. 30 W.
Lower Spunk Lake
Middle Spunk Lake
UPPER SPUNK LAKE
Lake Anna
Minnie Lake
Linneman Lake
Avon
BURLINGTON NORTHERN
AVON SANITARY LANDFILL
water
T. 125 N.
(Joins sheet 81)
(Joins sheet 83)
(Joins sheet 95)
(Joins sheet 96)
27
28
29
30
31
32
33
34

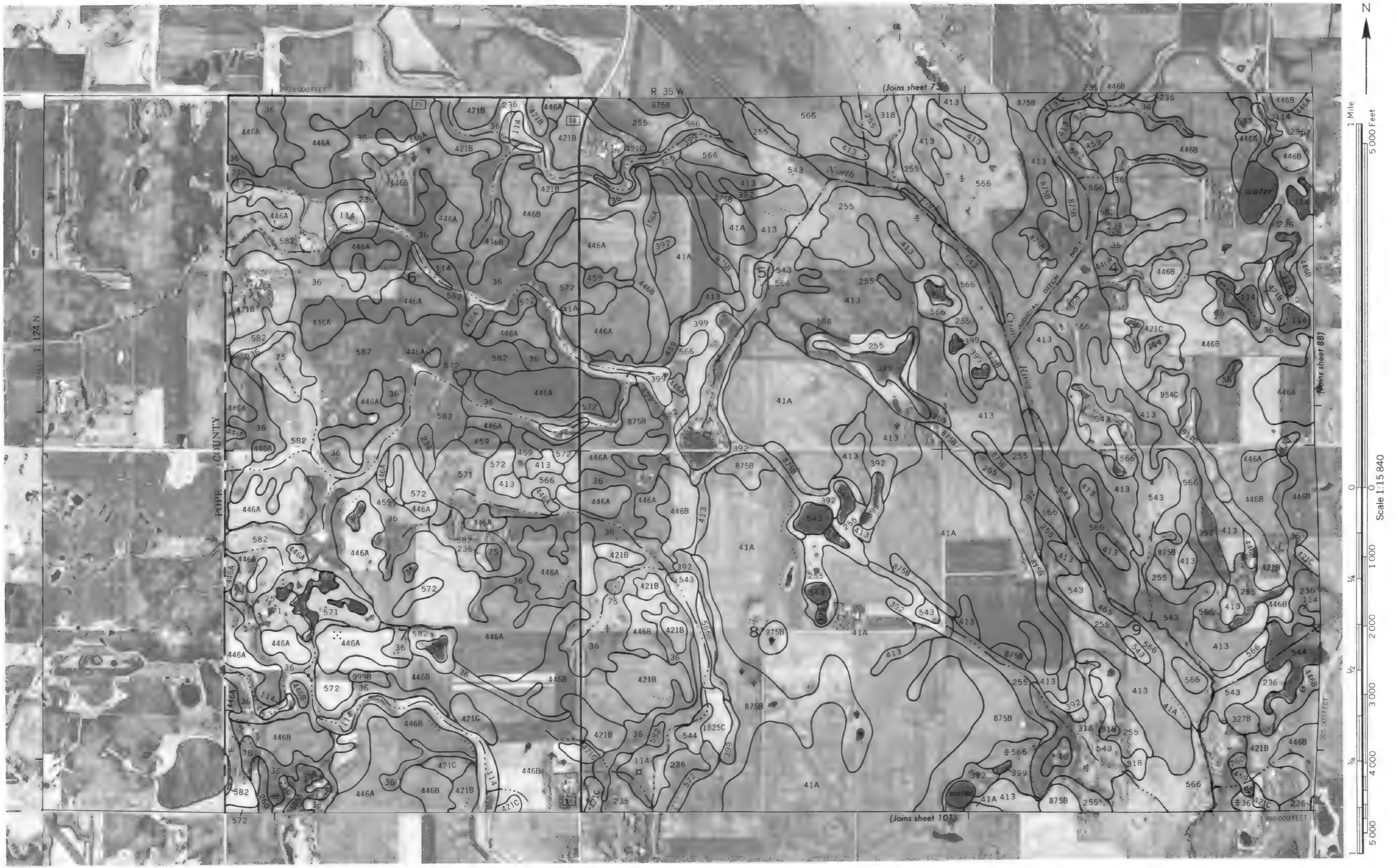

(Joins sheet 70)
R. 30 W.
R. 29 W.
Kepper Lake
Achman Lake
water
Watab River
North Fork
COLLEGEVILLE GAME REFUGE
Collegeville
BURLINGTON NORTHERN
COUNTY DITCH
(Joins sheet 82)
(Joins sheet 84)
(Joins sheet 96)
(Joins sheet 97)
25
26
29
30
31
32
35
36
N
1 Mile
5 000 Feet
Scale 1:15 840


N
(Joins sheet 71)
R 29 W
T. 125 N.
(Joins sheet 83)
(Joins sheet 85)
(Joins sh 97)
(Joins sheet 98)
Watab Lake
Rossier Lake
Watab River
Burlington Northern
28
27
26
29
32
33
34
35
1 Mile
5 000 Feet
Scale 1:15 840


R. 29 W.
R. 28 W.
(Joins sheet 72)
T. 125 N.
(Joins sheet 84)
(Joins sheet 86)
(Joins sheet 98)
(Joins sheet 99)
Watab Lake
WATAB RIVER
Five Points
COUNTY DITCH NO 16
SARTELL LAGOON
25
30
29
28
36
31
32
33
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
R. 28 W. (Joins inset, sheet 14)
2 020 000 FEET
SARTELL
SARTELL LAGOON
(Joins sheet 85)
BENTON COUNTY
MISSISSIPPI RIVER
SAUK RIVER
water
T. 125 N.
220 000 FEET
215 000 FEET
2 010 000 FEET
(Joins sheet 99) (Joins sheet 100)
27
28
33
34
35


R. 27 W.
MISSISSIPPI RIVER
SHERBURNE COUNTY
WRIGHT COUNTY
BURLINGTON NORTHERN
Clearwater River
T. 125 N.
(Joins sheet 85)
(Joins sheet 183)
26
27
34
35


(Joins sheet 73)
(Joins sheet 88)
(Joins sheet 101)
R 35 W.
T. 124 N.
POPE COUNTY
North Fork Crow River
JUDICIAL DITCH NO. 1
water
N
Scale 1:15 840
1 Mile
5 000 Feet


N
(Joins sh 73)
(Joins sheet 74)
R. 35 W.
R. 34 W.
T. 124 N.
(Joins sheet 87)
(Joins sheet 89)
(Joins sheet 102)
Scale 1:15 840
1 Mile
5 000 Feet


N
(Joins sheet 74)
(Joins sheet 75)
1 810 000 FEET
R. 34 W.
T. 124 N.
210 000 FEET
(Joins sheet 88)
(Joins sheet 90)
(Joins sheet 103)
825 000 FEET
2050 000 FEET
COUNTY DITCH NO. 7
COUNTY DITCH NO. 44
SOO LINE
Elrosa
5
4
3
8
9
10
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

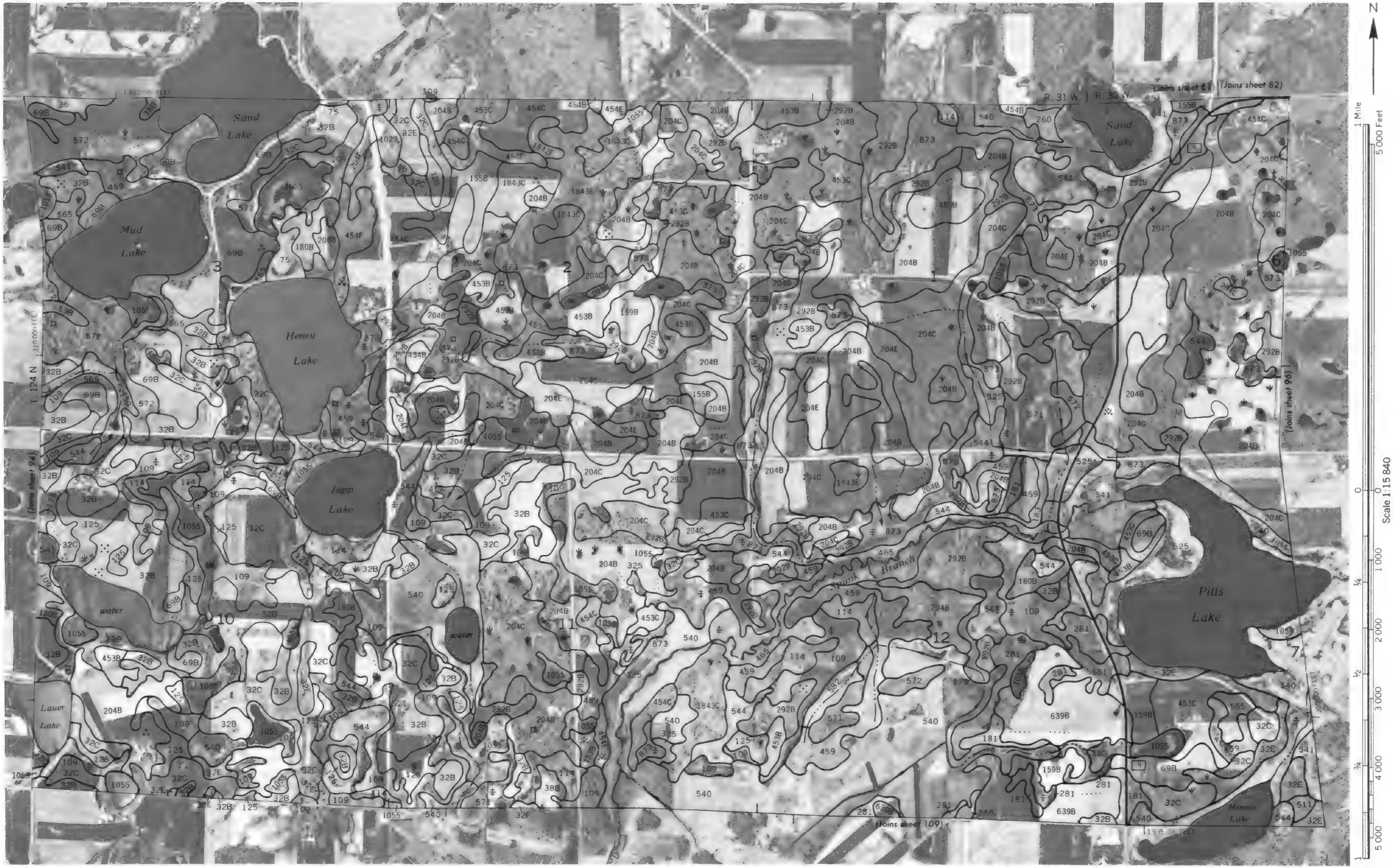
STEARNS COUNTY, MINNESOTA — SHEET NUMBER 90

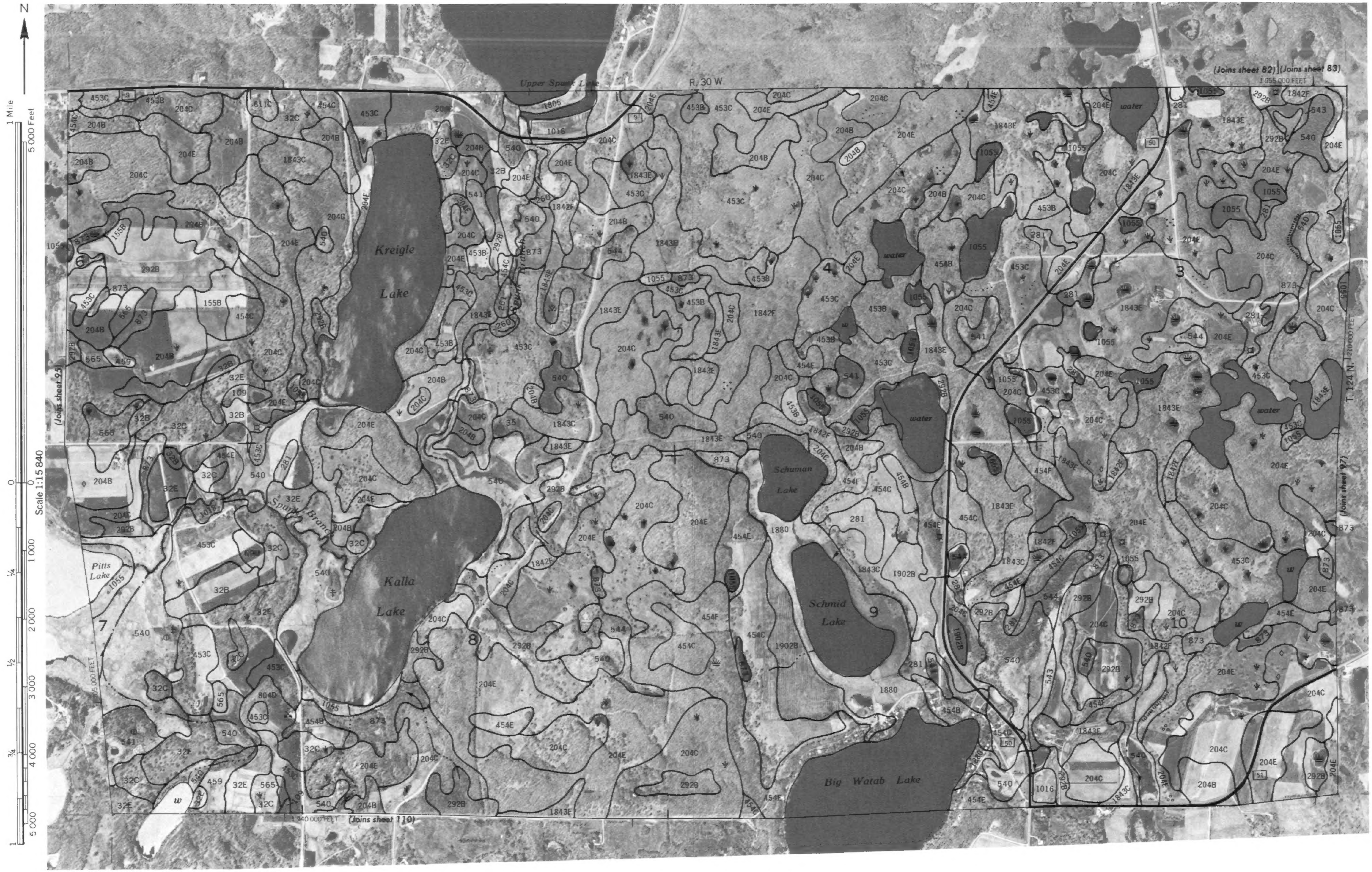

N
(Joins sheet 76)
(Joins sheet 77)
R. 33 W.
1 850 000 FEET
T. 124 N.
(Joins sheet 90)
(Joins sheet 92)
(Joins sheet 105)
water
water
Creek
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

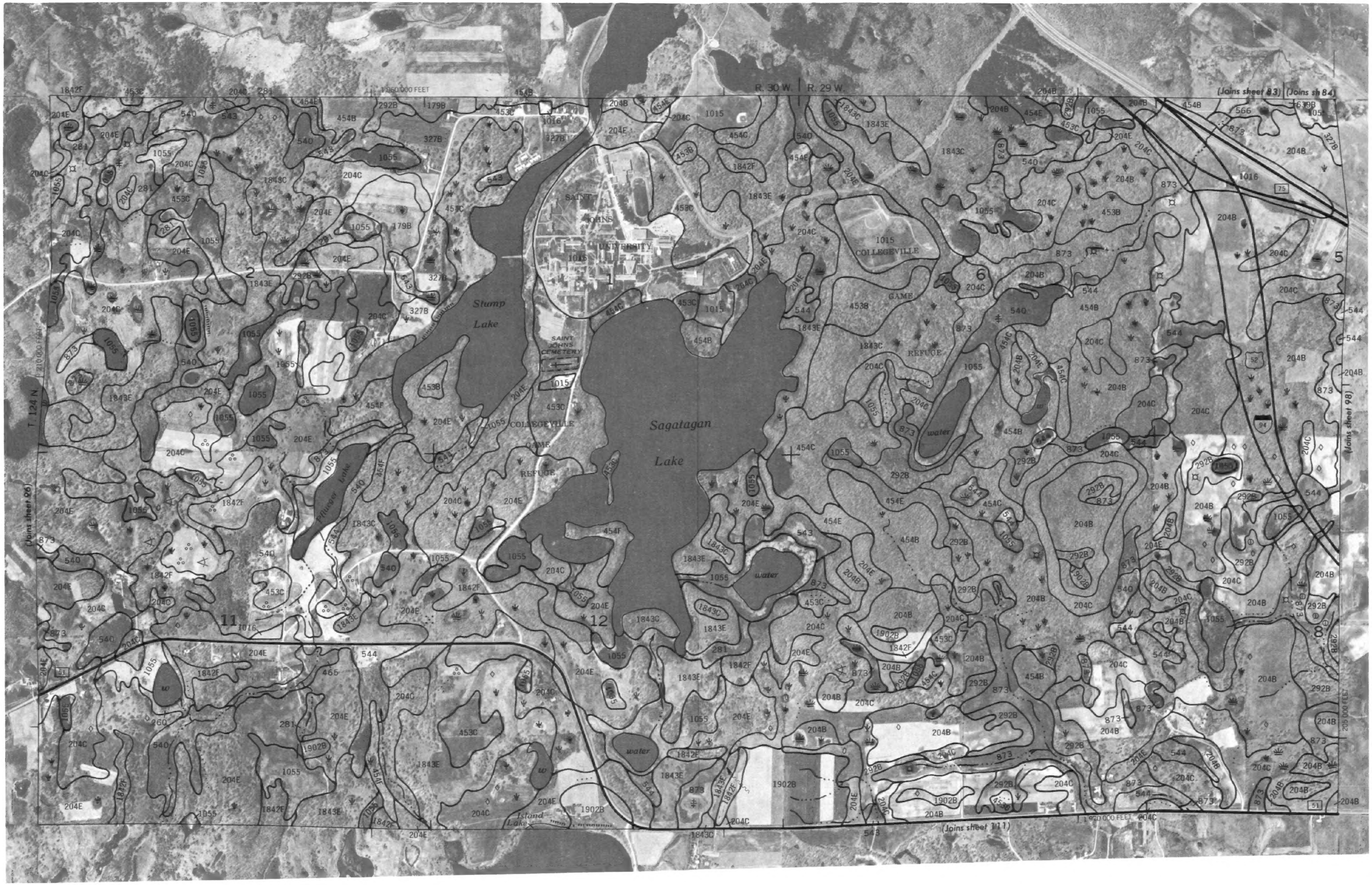

N
(Joins sheet 77)
(Joins sheet 78)
R. 33 W.
R. 32 W.
(Joins sheet 91)
(Joins sheet 93)
(Joins sheet 106)
T. 124 N.
Getchell
Creek
SAUK
RIVER
water
1 Mile
5 000 Feet
Scale 1:15 840

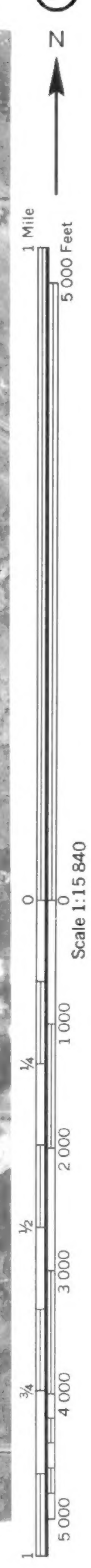

(Joins sheet 78)
(Joins sheet 79)
R. 32 W.
(Joins sheet 79)
(Joins sheet 80)
T. 124 N.
(Joins sheet 94)
(Joins sheet 92)
(Joins sheet 107)
Gravel Lake
water
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
R. 31 W.
T. 124 N.
(Joins sheet 80)
(Joins sheet 81)
(Joins sheet 93)
(Joins sheet 95)
(Joins sheet 108)
Eggert Lake
Lauer Lake
water
COUNTY DITCH NO 6
1 505 000 FEET
1 905 000 FEET

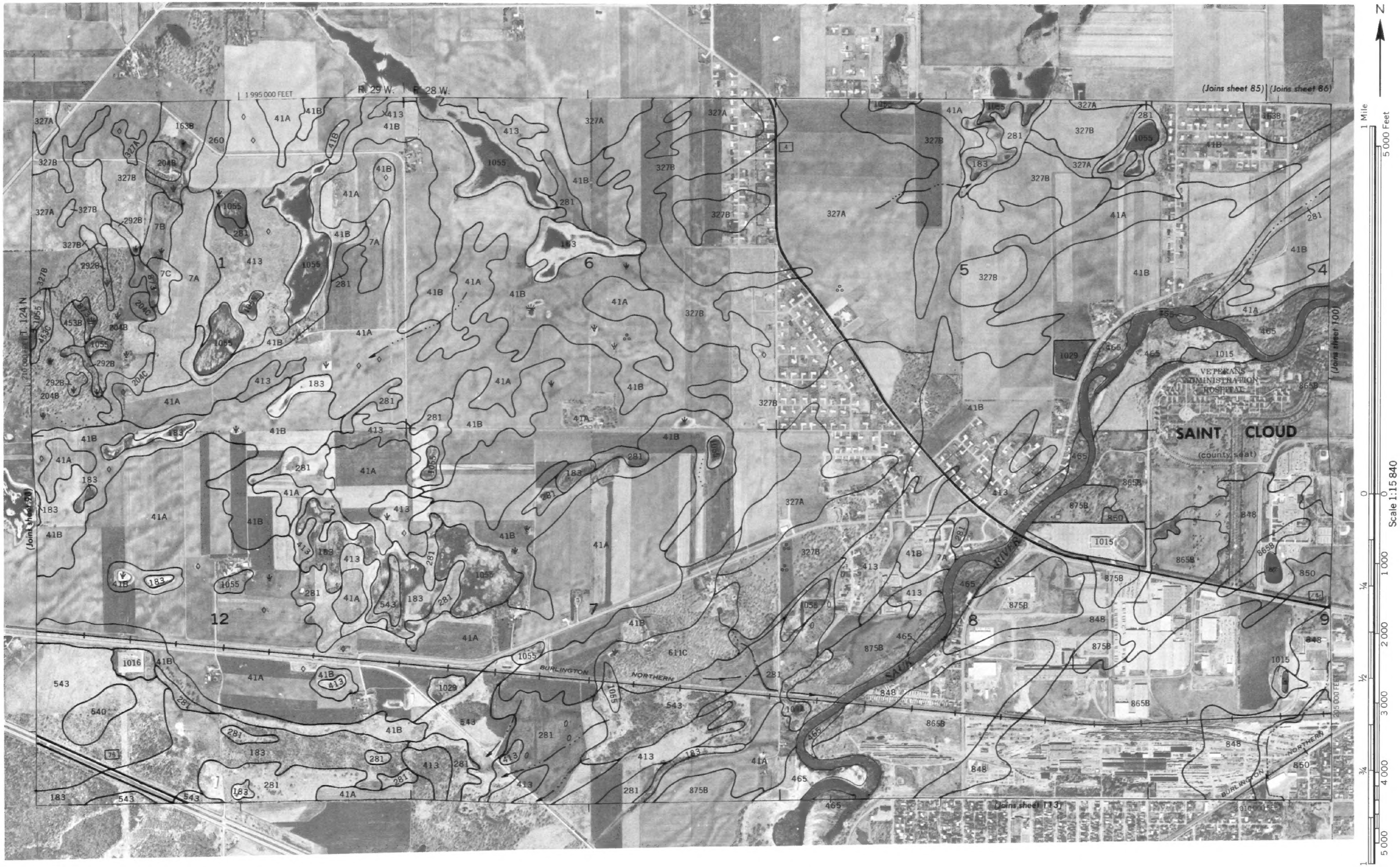

N
Sand Lake
Mud Lake
Henry Lake
Jopp Lake
water
Lauer Lake
Sand Lake
Pitts Lake
Minnie Lake
Spunk Branch
R. 31 W. | R. 30 W.
T. 124 N.
(Joins sheet 82)
(Joins sheet 94)
(Joins sheet 96)
(Joins sheet 109)
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 82)
(Joins sheet 83)
(Joins sheet 95)
(Joins sheet 97)
(Joins sheet 110)
R. 30 W.
T. 124 N.
Upper Spunk Lake
Kreigle Lake
Kalla Lake
Pitts Lake
Schuman Lake
Schmid Lake
Big Watab Lake
Spunk Brook
water
1 955 000 FEET
210 000 FEET
205 000 FEET
1 940 000 FEET


R. 30 W.
R. 29 W.
T. 124 N
(Joins sheet 83)
(Joins sh 84)
(Joins sheet 98)
(Joins sheet 111)
(Joins sheet 96)
Stump Lake
Sagatagan Lake
SAINT JOHNS UNIVERSITY
SAINT JOHNS CEMETERY
COLLEGEVILLE
COLLEGEVILLE GAME REFUGE
GAME REFUGE
Pflueger Lake
Island Lake
water
1 960 000 FEET
1 920 000 FEET
210 000 FEET
205 000 FEET


N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 84)
(Joins sheet 85)
1 990 000 FEET
R. 29 W.
210 000 FEET T. 124 N.
(Joins sheet 97)
(Joins sheet 99)
(Joins sheet 112)
1 975 000 FEET
205 000 FEET
North Fork
Watab River
South Fork
BURLINGTON NORTHERN
SAINT JOSEPH
COLLEGE OF SAINT BENEDICTS


N
(Joins sheet 85)
(Joins sheet 86)
(Joins sheet 100)
(Joins sheet 113)
(Joins sheet 98)
1 995 000 FEET
R. 29 W.
R. 28 W.
T. 124 N.
SAINT CLOUD
(county seat)
VETERANS ADMINISTRATION HOSPITAL
BURLINGTON NORTHERN
SAUK RIVER
1 Mile
5 000 Feet
Scale 1:15 840